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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

(INTERNATIONAL.)

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

At the Atlantic City Boardwalk fire on December 30 the value of the High Pressure Fire System was convincingly demonstrated. (See editorial on opposite page.)

The Quarterly

Vol. 16 January, 1923 No. 3

Hats Off to Mr. Bell! The use of the Atlantic City high pressure water service system at the $250,000 fire on the afternoon of December 30th (see Frontispiece) which originated in the Moulin Rouge, a cafe just off the Boardwalk at New York Avenue, saved that locality from a conflagration that for a time threatened to consume several million dollars' worth of property and visit upon the city its worst Boardwalk disaster since the great fire of 1902 that wiped out the central business and hotel section of the ocean front.

This fire of December 30th was marked by spectacular features and dramatic rescues. In the most dramatic scene of all the high pressure system was a factor. When the flames menaced the McCrory apartments the clouds of smoke drove its occupants down the fire escapes on the ocean side and across roof-tops to the east. Under the apartments is the McCrory five and ten cent store. Girl clerks, not aware of their danger, had started covering show-cases with fire blankets. A quick blast of smoke and fumes caught them and a dozen were carried out semi-conscious. Suddenly during this excitement there appeared on the third floor of the apartments at a corner window a white-clad nurse making voiceless signals to the crowd below. She had a woman patient in bed with a fractured hip. Escape was entirely cut off by the stairways by heat and smoke vomited from the blazing structures in the rear. With the help of volunteers who dashed up to the room through the stifling gases of the corridor the patient was moved in her bed to the open front window and wrapped warmly in fur coats. There the nurse stood beside her while the dense clouds of smoke enveloped the entire building. Breathless thousands fearing a tragedy focussed their attention on the little drama at the window. The flames were licking up the sides of the structures beyond, slowly creeping toward the apartment. The window was frequently blotted out by the rolling smoke clouds that hugged the bricks and was sucked into it by the heat at the back. Each time the pall lifted the crowd saw the brave nurse, Mary Gallagher, encouraging her helpless patient.

The fire department rose to the situation. An entire crew concentrated the high pressure streams on the areas that threatened the section where the women were. Slowly but surely the heavy artillery hose streams began to drive the flames back, the hosemen drawing in closer and

closer until the sickly yellow pall was replaced by the white vapors that mutely told the story of victory. It was a thrilling conquest and the fascinated crowd cheered and cheered again.

But whose victory was it? Was it one of water over fire? As an outward and visible sign, yes. In reality it was a victory of mind and character over the forces of inertia. The lives of these two women, and beyond doubt millions in property, were saved long before December 30th by the persistence and pleadings and devotion of Albert T. Bell, who never permitted indifference or ignorance or false notions of security to swerve him from his purpose to create for Atlantic City a dependable system of fire defense. The story of this splendid achievement, so modestly told, appears on page 286 of the N. F. P. A. *Proceedings* of last year. If the members of our association, looking back at the creation of this barrier to another potential great Atlantic City conflagration on December 30th feel an enthusiastic pride in the quiet, forceful, competent chairman of our Executive Committee, will anybody challenge our reason for it?

* * * * *

The Annual Inventory. While statistics of fire loss for 1922 are not yet available as this issue of the QUARTERLY goes to press, the indications are that losses for the year will again break previous records. The estimates by the New York *Journal of Commerce* for fire losses in the United States and Canada show a total of $363,453,350 for eleven months of the year compared with $303,747,400 for the same period in 1921 and $289,658,025 in 1920. Assuming that the usual relation will be maintained between the *Journal of Commerce* estimates and the statistics compiled from insurance loss reports by the Actuarial Bureau of the National Board of Fire Underwriters, it seems safe to predict that the total loss shown by the Actuarial Bureau report, when completed, will be well over $500,000,000. Comments on the enormity of this waste need not be repeated—the figures speak for themselves. But amid this continually increasing destruction we can take comfort in the conclusions drawn by Member Worthington in the article appearing on another page of this issue. He shows that though the grand totals of fire loss are increasing, the "fire tax rate," or rate of burning per thousand dollars of combustible property, has been reduced from the high point of $3.57 for the five year period 1890-94, to $1.71 for the years 1920 and 1921. This increase in the "fire tax rate," beginning at the period of the organization of the N. F. P. A. and showing progressive improvement during all the years of organized fire prevention effort, gives very good evidence that our work has not been in vain and leads us to hope that not only the rate but also the total losses can soon be lowered.

For loss of life there are unfortunately no statistics comparable to those for property losses. The estimates of T. Alfred Fleming, chairman of the Committee on Fire Prevention Week, based on the exact returns from North Carolina and such other places as afford reliable loss of life reports, show an annual total of 15,000 killed and 17,000 injured by fire. Member Clarence Heller in his article on Safeguarding Life from Fire, in the October QUARTERLY expressed the opinion that these figures are high, and that the actual total toll is not more than 10,000 lives. Either figure should be sufficiently damning to have a profound effect on the

public, though the vast public indifference still remaining would indicate that the Fire Demon's toll of human lives has passed almost unnoticed save in isolated cases where the magnitude of some holocaust or the nearness of some disaster has furnished sufficient shock to arouse temporary interest. The recent series of serious loss of life fires reported in this issue have all played their part in public education. If lives must be sacrificed because of public indifference it is far better that they be lost in a few major calamities rather than go one or two at a time, for while group sacrifices have influence in securing improvements, the loss of individual lives seems to have little effect. The recent New York factory fires, for example, called forth some valuable local newspaper editorials, and had some countrywide influence as shown by the comments of the *Literary Digest*. Among this quarter's reports there appears an unusually large loss of life in school and college fires. These losses should accelerate the movement, already well under way, for fire safe schools.

* * * * *

At Spigot and Bunghole Both. The comparatively few people in America who pause in their personal preoccupations long enough to try to comprehend economic forces and their effect upon the individual's struggle for a livelihood are undoubtedly impressed by the stupendous proportions of the fire waste of the past few years. But how many even of these, the best and most intelligent citizens we have, realize how the expenses are creeping up on the fire extinguishing end? Let them investigate the reason for the increasing municipal tax rates and they will see. The New York State Bureau of Municipal Information in a recent report states that during 1921, maintenance of New York's fire departments cost the state as a whole $23,970,859 as against $13,100,984 in 1916, an increase of 83 per cent. Shorter hours and increased salaries are given as the chief causes of the increase; but this is obviously a mere surface conclusion. The size and cost of our fire departments might be reduced one-half if our people could be brought to understand the frightful burdens they impose upon themselves by their carelessness with fire. There seems to be no limit to our fire foolishness short of national bankruptcy.

* * * * *

A Texas Sprinkler Success. When a little trouble is taken to secure at least a degree of fire protection while waiting for the maximum it is a comfort when some event justifies such forethought. Herbert H. Sutton (Member N. F. P. A.), of Dallas, sends in a story of a fire in a local ice cream factory which furnishes an illustration.

In this property, which had a refrigerating ice plant in connection, a standard one-source dry-pipe automatic sprinkler system was almost completed, the pipe and heads being in position. While the city officials were considering the proper size connection, which was at first refused and thus delay was involved, the installing sprinkler company made a three-quarter inch connection to the domestic service line in the building, cut off the sprinkler alarms, and maintained the equipment as a wet-pipe system temporarily. The static pressure from the city mains was 58

pounds. At three o'clock one morning a fire originated in some rubbish on the second floor, spreading to a stock of paraffin cartons. A sprinkler head opened and extinguished the fire with a loss of but twenty-five dollars.

* * * * *

The Inflammable Picture Film. The Fire Marshals Association of North America, following the resolution unanimously adopted at its convention in September, has caused to be introduced in Congress a bill designed to prohibit the handling of the nitro-cellulose picture film in interstate commerce after January 1, 1925, the date upon which it is to be outlawed in Paris. Following is a draft of the bill:

67th Congress,
4th Session.

H. R. 13448.

IN THE HOUSE OF REPRESENTATIVES.

December 16, 1922.

Mr. Sanders of Indiana introduced the following bill; which was referred to the Committee on Interstate and Foreign Commerce and ordered to be printed.

A BILL

To prohibit the importation and the mailing, shipment, sending, carrying, or transportation of inflammable films in interstate commerce.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the 1st day of January, 1925, it shall be unlawful for any person to deposit or cause to be deposited in the United States mails, for mailing or delivery, or to deposit or cause to be deposited with any express company or other common carrier, for carriage, or to send or carry from one State or Territory of the United States, or the District of Columbia to any other State or Territory of the United States or the District of Columbia or to bring or cause to be brought into the United States from any foreign country any inflammable films.

Sec. 2. (a) That the word "film" or the words "inflammable films" as used in this Act shall mean material generally used for reproduction purposes in the commercial photographic process of making a positive from a photographic negative (having a thickness of not to exceed ten one-thousandths of an inch).

(b) "Inflammable films" shall mean a film or films made of, or from, any compound of materials having the quality, character, and content of, or that is or may be similar to nitrocellulose as the basic compound used in its or their manufacture, but shall not mean any such films that shall have been given any protective coating or covering designed to render and which renders the films flameproof or to protect them against combustion, decomposition, or deformation upon the application of or when subjected to heat at or above a temperature of seventy-five degrees Fahrenheit.

(c) The word "person" as used in this Act shall mean individual citizens, firms, associations, societies, corporations, copartnerships and partnerships.

Sec. 3. That any person violating any of the provisions of this Act shall for each offense, upon conviction thereof, be punished by fine of not more than $1,000, or by imprisonment for not more than one year, or by both such fine and imprisonment.

The local fire marshals are communicating with their senators and congressmen, explaining the hazards of the rapidly extending non-professional use of the inflammable film and urging their support of the above measure. This action by the Fire Marshals Association is singularly in advance of that of the National Convention of Insurance Commissioners which was asked at its September convention, by Commissioner Stacey W.

Wade of North Carolina, to adopt a resolution similar to that passed by the International Association of Fire Engineers and the Dominion Association of Fire Chiefs in August and by the Fire Marshals Association in September. Commissioner Wade's resolution was put to death by reference to an inactive committee after a speech by the Honorable Francis R. Stoddard, Insurance Commissioner of New York, in which he insinuated that the Secretary of the N. F. P. A., who was present and favored the passage of the resolution, was the representative and agent of a slow-burning film monopoly.

The date named in the proposed resolution, January 1, 1925, for the abolition of the use of the inflammable film, seemed reasonable inasmuch as the American patents controlled by the Kodak Company for the exclusive manufacture of the acetate or safety film expire this year.

* * * * *

The Inflammable Film in Milwaukee. Meanwhile only a kind fate is deferring the holocausts that are certain to follow, sooner or later, the use of the gun-cotton film. In the Milwaukee Sunday papers of December 17th a large department store, as a striking illustration of general ignorance on this subject, advertised the sale of one-hundred-foot lengths of picture film as "the regular stock used by theatres." Twenty thousand feet of this film was exposed on sale in this one store, intended for the children of Milwaukee. *It had been placed there on consignment by a motion picture operator.* The department store advertisement was brought to the attention of the building department, and Inspector Harper immediately issued an order to all the picture houses and film exchanges to gather up any picture film placed in Milwaukee stores for sale or suffer arrest and revocation of license. The department also issued a public notice to parents who had purchased the inflammable film to return it at once. A general investigation disclosed stocks of this film in many stores in Milwaukee, some of it having been imported from abroad.

It is because the state and city fire marshals and other authorities do not feel that they can successfully protect the public against the hazards of the inflammable film that they are demanding the abolition of its use through Congressional action.

* * * * *

Sprinkler Alarms and Policemen. Boston had a bad fire early one morning recently in an old building of inferior construction in the heart of the city, occupied for vending antique furniture, rugs and curios. The fire started on the first floor, extending to the floors above. The basement of the building was protected by an automatic sprinkler system with an outside water-motor gong and an inside electric gong. The fire evidently burned quite a long time before it extended by way of an open stairway to the basement where its progress was checked by the opening of three sprinklers. Investigation indicated that the sprinkler alarm gongs had been ringing for thirty minutes, ignored by the neighbors who heard it and by the passing policemen. When a policeman actually saw the fire he called the fire department from a street signal box.

Chief Taber of the Boston Fire Department and Engineer Osgood of the Boston Board of Fire Underwriters were considerably disturbed

by this circumstance and sought an interview with Boston's new police commissioner, who was found quite willing to co-operate and agreed to issue a general order to the police on the subject, explaining the purpose of such alarms and giving instructions as to procedure in case of their operation.

The drafting of such an order revealed the need of uniformity in the matter of signs indicating the sprinkler alarm, and the sprinkler companies were appealed to for suggestions on this item. A conference on the subject brought out a reasonable unanimity of opinion respecting the following points:

(1) The gong should be in a conspicuous place on the building.
(2) The gong hood should carry the words "Sprinkler Alarm" or some equivalent designation.
(3) A plate properly worded, which may be attached to the building, is probably the best method for uniform marking; this plate to be provided in all cases without regard to any marking on the hood.
(4) The method of marking should be distinctive in color and should be uniform.
(5) Painted lettering on the building is not considered satisfactory.
(6) The marker should be provided by the sprinkler contractor, and if the manufacturer's name is included it should be inconspicuous.
(7) The words most clearly expressing what is desired seem to be:

FIRE SPRINKLER ALARM:
NOTIFY POLICE.

It was conceded that as such signs may be required upon all buildings having outside sprinkler alarms the cost of the same should be as low as may be consistent with a reasonable durability. In many cases the sign may be located on a building front where the appearance must be considered and probably where objection to the location of any sign may be encountered. In may cases in Boston, and probably in other cities, the gong is located low down, frequently in a basement window, while in other cases it may be placed at the second floor level.

The promoters of this Boston plan of police co-operation are not insensible to the responsibility it will place upon contractors, inspectors and others making tests of sprinkler alarms to use care not to ring gongs needlessly and to arrange to notify the officers who may respond when the gong is heard.

* * * * *

The New N. F. P. A. Marine Regulations. The recent explosion on the tank steamship Pew, while undergoing repairs at a Delaware River shipyard, forcibly calls attention to the importance and value of the new Regulations prepared by the N. F. P. A. Committee on Marine Fire Hazards. Two men were killed, eighteen were injured and damage to the extent of $300,000 was caused by this explosion. It is reported that while the particular oil tank in which repairs were under way had been cleaned and declared gas free, adjacent tanks had not been freed of vapors as required by the N. F. P. A. Regulations. The investigating committee, headed by S. D. McComb, chairman of the Marine Fire Hazards Committee, has not yet reported on the responsibility for this explosion, but it would seem difficult for those in charge to evade responsibility for ignoring the section of the Regulations dealing with the

freeing of tanks from explosive vapors, especially in view of the fact that this section has been adopted by and is one of the official requirements of the American Bureau of Shipping.

Even with the present comparative inactivity in American shipping, there is a wide and important field for the work of Mr. McComb's committee. The many recent ship fires, the explosion which caused the sinking of the Charles Bradley off Tampico on July 25, the fire on the steamer Colthraps at Pensacola on September 5 when one life was lost, the destruction of the Golden West No. 2 at Eureka, Cal., on September 22, the spectacular burning of the City of Honolulu while 700 miles from San Francisco on October 12, and the fire involving three river steamers at Cincinnati on November 4, all furnish eloquent testimony to the vital need for this work.

* * * * *

Preventing Bridge Fires. On another page will be found the report of the cooperative committee on the prevention of fire in timber floors of highway bridges, of which George W. Booth (member N. F. P. A.) is chairman. The frequency of bridge fires and the lack of attention given to fire protection in ordinary bridge construction make this report one of especial interest.

The evidence shows that the great majority of bridge fires are attributable to the careless smoker. For example, the Fire Commissioners of Holyoke, Mass., report that practically all of the bridge fires in that city in the year 1921 were due to cigarette stubs. In June, 1921, there were 64 bridge fires in Holyoke. Later the number of fires was diminished by means of frequent sprinkling. The Holyoke Fire Commissioners in their annual report say: "While the Department has been very fortunate in the past in extinguishing bridge fires at a minimum loss, there is always danger of such a blaze getting so much headway as to cause the loss of one of the bridges."

Additional data on bridge fires comes from Mr. John D. Stevenson, assistant chief engineer of the City of Pittsburgh:

"The city has several steel bridges having wooden floors. Some of these are large structures crossing the rivers and are important arteries of traffic. During the hot, dry periods of the summer, fires on these bridges are very frequent. They are of minor importance only, because we have been successful in extinguishing them before the flames have taken much of a hold. During the last summer, on one bridge fires were a daily occurrence and not infrequently two or three fires occurred in one day."

Executive Committee Action.

The executive Committee has taken favorable action by letter ballot upon recommendations made by the Committee on Manufacturing Risks and Special Hazards and the Committee on Automatic Sprinklers concerning certain revisions in the text of the Regulations governing Dip Tanks, etc., and the Regulations governing Automatic Sprinklers as adopted by the Association in annual meeting, May, 1922.

Regulations Governing "Dip Tanks," Etc.

At meeting June 29, 1922, the Executive Committee referred to the *Committee on Manufacturing Risks and Special Hazards* for further consideration, the proposed modification of the requirement for capacity of foam supply under classes A, B and C of general rules covering foam extinguisher systems.

The committee held a two-day meeting in Detroit, October 16-17, at which time the whole report, with especial attention to the points referred back, was thoroughly considered, representatives of manufacturers heard, and inspections made of the hazards covered by the report as found in three Detroit automobile factories. At one of these plants a fire test of foam, simulating the conditions contemplated in the report, was witnessed. Eleven of the fifteen members of the committee were present (or represented) at this meeting who unanimously favored immediate promulgation of the regulations, incorporating the following changes:

Points referred back (Refer to committee report p. 301, Proceedings 1922).

1. P. 328, 2 (a). This paragraph is amended to read:—

   A supply of solutions must be maintained sufficient to *deliver* 2.5 to 5.0 gallons of each solution per sq. ft. of surface of the largest individual liquid surface area to be protected, (*one gallon of each solution* (*two gallons of combined solutions*) *being assumed about equivalent to 2 ft. of foam per sq. ft.*) depending upon local conditions such as the volatility of the liquids, character of obstructions likely to interfere with fire extinguishment (such as roof supports), and *in addition sufficient to provide for* the exposure of other tanks and the usual temperature of the oil, and such reserve storage supply as may be called for by the Inspection Departments having jurisdiction.

2. P. 331, 1. This paragraph is not changed in intent but is reworded as follows:—

   "Supply of foam-producing liquids shall be maintained sufficient to deliver upon the area protected in any one fire section a blanket of foam not less than six inches deep (about equivalent to ¼ gallon of each solution (½ gallon of combined solutions) per sq. ft., having an expansion of 8 at ordinary temperatures) and an amount in addition thereto depending upon the local conditions such as severity of the hazard, obstructions likely to interfere with the distribution of foam (in construction of building and contents), also due allowance to be made for the amount of foam required to fill the extinguishing system and for foam not otherwise actually dis-

tributed. Inspection Departments having jurisdiction shall be consulted in each case as to the minimum amount of foam to be required."

3. P. 333, 1. This paragraph is changed to permit reduction of foam requirement in special cases, as follows:—

"Supply of foam-producing liquids shall be maintained sufficient to deliver upon the area protected a blanket of foam not less than six inches deep (about equivalent to ¼ gallon of each solution (½ gallon of combined solutions) per sq. ft., having an expansion of eight at ordinary temperatures) and an amount in addition thereto depending upon the local conditions such as severity of the hazard, obstructions likely to interfere with the distribution of foam (in construction of building and contents), also due allowance being made for the amount of foam required to fill the extinguishing system and for foam not otherwise actually distributed. For tanks having an area of less than 25 square feet not less than half the above quantity may, under favorable conditions, be accepted by the Inspection Department having jurisdiction. Inspection Departments having jurisdiction shall be consulted in each case as to the minimum amount of foam to be required."

Additional changes.

4. For convenience of reference and use the entire report is renumbered with consecutive paragraph numbers, and the main sections are lettered instead of numbered, all in style similar to the Sprinkler and other existing regulations. The sections on Automatic Covers and Automatic Drains are made sub-sections under Dip Tanks, as they are logically a part of this subject.

5. Because of a general feeling that the title was too inclusive and did not properly indicate the subject matter, the title is changed to read as follows:— "Regulations governing DIP TANKS, Hardening and Tempering Tanks, Flow Coat Work, Spray Booths, Japanning and Enameling including Ovens, and Foam Extinguisher Systems."

6. The report has been edited throughout with the object of clarification of meaning, especial attention having been paid to clearly differentiating between requirements and advisory matter.

Regulations Governing Automatic Sprinklers.

Additional revisions recommended in regulations governing Automatic Sprinklers as amended at annual meeting May, 1922.

(a) Reference: Illustration page 30, Sprinkler Regulations, Edition 1920. The location of the test pipe to be inside (at right of) valves instead of as shown in this cut.

(b) Reference: Proceedings 1922, page 78, paragraph 49, *Size of Dry System.* A fine print note is to be added to this paragraph for the purpose of furnishing data helpful in computing the capacities of sprinkler systems. The suggested text of this fine print note is as follows:

"TABLE OF CAPACITIES OF WROUGHT IRON PIPE. There is no standard for all manufacturers. The outside diameter of pipe is made exactly to standard in order to fit the dies. The skelp from which the pipe is made is of a thickness to make the pipe weigh the standard per foot; but a variation of 5% above or below is permitted. The inside diameter and therefore the capacity will vary slightly and no table is strictly accurate. The fittings will also make a slight difference, but for the application of the above rule, the following table is substantially correct:—

Nominal Internal Diameter in Inches	*U. S. Gallons in One Lineal Foot of Pipe*
¾	.028
1	.045
1¼	.078
1½	.106
2	.174
2½	.248

Nominal Internal Diameter in Inches	*U. S. Gallons in One Lineal Foot of Pipe*
3	.383
3½	.513
4	.660
5	1.040
6	1.501

The gallons per sprinkler will naturally vary with the arrangement of the system. Under standard requirements the smallest quantity per sprinkler would be .741 gallon under 8 ft. stagger in 11-6 to 12 foot bays joisted construction, and the greatest 1.714 gallons under practically 10 x 10 ft. spacing panel construction; but in equal areas the total capacity of each system per floor would be nearly the same due to the greater number of sprinklers under the joisted construction. Approximate capacities may be obtained under general types of construction by allowing per sprinkler 1.1 gallons under centre feed; 1.25 gallons under side and end centre feed, and 1.6 gallons under panel construction. These include allowances not in excess of 14 ft. for riser pipe and of 10 ft. from riser to system on each floor. They do not include any long runs from dry-pipe valve to system."

The National Board of Fire Underwriters in conformance with action taken respecting the above is to print at once the Regulations governing "Dip Tanks, etc.," and is to issue a new and revised edition of the Regulations governing Sprinkler Systems.

Business Man—"Terrible! can't we do something to help kill the beast?"
Legislator—"Let George do it. It's really none of our business you know."

Courtesy Whittlings.

Fire Prevention Week 1922.

By T. Alfred Fleming.

Chairman, Committee on Fire Prevention Week.

Education is the solution of the great problem of fire waste. This has been demonstrated in analyzing the results of the Fire Prevention campaigns in the past years. For this reason, the Committee on Fire Prevention Week outlined activities for 1922 particularly emphasizing the feature of permanency through proper methods of public instruction.

Following the Proclamation of the President of the United States, executives of all but three states of the Union, and over 90 per cent of the mayors of the large cities issued appeals for general civic observance of Fire Prevention Week. An official Proclamation was issued by the Governor-General, followed by a direct message to the public by the Prime Minister of Canada, copies of which were used in large quantities with good effect by all the provincial fire marshals and other officials in connection with the campaign.

Satisfactory results can be obtained only by the coöperation of all interests, social and civic. With the strength of the United States Chamber of Commerce, the National Fire Protection Association, and the National Board of Fire Underwriters behind the movement, it was a comparatively easy matter to interest all men of public affairs, and early in the season the officials of the National Association of Credit Men and National Association of Manufacturers, Rotary, Kiwanis, Lions, Exchange, and other luncheon clubs called upon these organizations to set apart one meeting to the study of Fire Prevention. Thousands of speakers were supplied, many of whom were special agents of the insurance companies or members of the National Association of Insurance Agents. The President of the National Association made Fire Prevention one of the salient accomplishments of his administration. It is impossible to estimate the effect and results of these meetings, which were held by thousands for the first time in a Fire Prevention Week celebration. The above mentioned luncheon clubs are composed of the best and most representative men of all lines of industry in every community. Accurate material was prepared and forwarded to every state, so that all speakers might be supplied with data, statistics, etc., for addresses.

Since Radio has become the new and most efficient avenue of communication, the broadcasting stations were requested to give place to a speaker on their programs. Two hundred and thirty-eight gladly responded, and speakers of prominence were assigned to each. Some stations were used every night of the week for the discussion of different phases of the subject; others both afternoon and evening.

The fire marshals of the several states were particularly active in the direction of work in their territory and the fire chiefs and municipal Fire Prevention Bureaus supplied schools with material for class study,

and also gave addresses to the students during assembly. The program for schools was carried out more consistently than ever before.

The playlet entitled, "The Trial of Fire," prepared by the National Board of Fire Underwriters, was put on by the children in hundreds of schools. In many instances, this performance was staged at the leading theatre of the city, accompanied by the unusually large community interest which follows such a school entertainment.

In the city of Wilmington, Delaware, the practical efficiency of organization was demonstrated in a most comprehensive manner. The general committee of the Chamber of Commerce, at the suggestion of a prominent National Fire Protection Association member, secured the coöperation of, and assigned special phases of the campaign to all the municipal, civic, and social organizations as follows:

The Mayor—Suitable proclamation.

The City Council—Improvement to Fire Ordinances.

The Rotary Club—Fire Prevention Work in Schools, including special lessons, lectures, inspection, and drill.

The Kiwanis Club—Inspection of theatres, four-minute speakers, and film display.

Lions Club—Coöperation of the ministers in giving a fire prevention talk in all churches.

Manufacturers' Association—Inspection of factories.

The Safety Council—Fire Prevention Work in homes.

Central Labor Union—Teaching fire prevention to workmen.

Insurance Fraternity—General publicity, street banners, and displays.

City Fire Department—Inspection of the mercantile district.

All of these organizations made most commendable reports to the general committee.

In the city of Atlanta, the local insurance board published 40,000 copies of a specially prepared pamphlet for use in all the schools. Besides many other valuable features, they also had a small, but very complete house built at considerable expense, which exhibited all the hazards of the home. The house was a part of an exhibit prepared for the State Fair. It was completely furnished with miniature furniture, and mounted on a turntable, so that it was moving at all times. One side of each room was open, displaying the usual dangerous conditions to be found. The ends of the attic were open, disclosing ordinary attic conditions. There were two chimneys; one properly constructed, and the other seriously defective. One side of the roof was covered with wooden shingles, and the other with fire-resistive material. The construction of this house was so arranged as to be easily taken apart in sections and shipped to other cities, where the exhibit will be displayed throughout the year under the auspices of the State Association of Insurance Agents.

Our Canadian members were very active this year. The celebrations held in Quebec, Montreal, Ottawa, and Winnipeg were particularly good. The fire marshals in the several provinces secured the support of all leading organizations, and in a number of instances Fire Prevention Leagues were organized to function continuously.

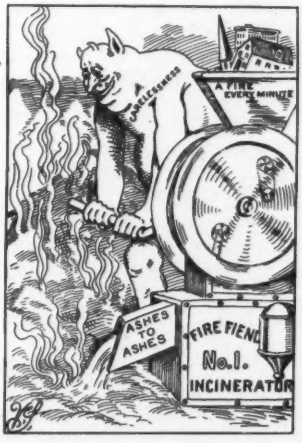
The need of fire prevention films was again clearly demonstrated, as the available supply proved to be hopelessly inadequate for the requests received.

The reports received have shown a marked interest taken by the public press of the country, as editorial space was given in all the leading newspapers. Editors emphasized our individual obligation to eliminate a community loss and frequently advocated personal liability legislation. Editorial comment is given only to problems of vital importance which have aroused general public interest, and, therefore, the success this year in creating public sentiment is the direct result of the harmonious co-operation of all organizations concerned in public welfare.

The Railway Fire Protection Association carried on an extensive campaign over all the railway systems, and some very effective results were secured. The members of this Association also contributed largely to the success of the general campaign in their places of residence.

In many communities the spasmodic activity of the week's celebration has developed a permanent organization with a well-laid plan for a continuous campaign.

On behalf of the Committee, may we express to all members our appreciation for their hearty coöperation in making the celebration for 1922 by far the most far-reaching and important in history.



The Daily Grind

Courtesy Whittlings.

The Decreasing Fire Tax Rate.

By Charles E. Worthington.

(Member N. F. P. A.)

While annual fire losses in the United States and Canada have been increasing year by year to the present enormous totals, the values of property subject to destruction by fire have been increasing at an even greater rate. The amount of annual fire loss per thousand dollars of combustible property has, therefore, been decreasing as shown by the data given in this article.

We have wasted by fire in the United States in the 45 years 1876-1920 inclusive at least $7,605,513,557 and probably as much as $10,647,718,980. These figures are taken from the published tables of the National Board of Fire Underwriters. The smaller figures, used in this article as "old style bookkeeping," are based on estimates of the New York *Journal of Commerce* which are used in the reports of the National Board for the years before the complete statistics of its Actuarial Bureau were available. The Actuarial Bureau statistics, designated as "new style bookkeeping," show considerably larger total fire losses. Applying to the earlier figures the forty per cent difference between the results of "old style bookkeeping" and "new style bookkeeping" we can estimate what the total fire loss figures might be if the Actuarial Bureau statistics were available back to 1870. There is little room, if any, for doubt as regards the substantial accuracy of the new compilation as compared with the older method. The $10,647,718,980 total mentioned above and the larger loss figures used in this article are computed on this basis. The loss in 1876 was $64,630,600-$90,482,840, in 1920 $319,920,047-$447,886,677, the 1920 figures being in either case 495 per cent of 1876.

The loss by the Chicago conflagration of 1871 is not included in the estimates because the magnitude of the calamity and other conditions take it out of the category of ordinary fire losses. Lest the actual importance of the Chicago fire be overshadowed by the large volume of loss in later conflagrations it is well to state that it would have required for compensation an addition to the tax rate of every property holder in the United States at that time of 68.2 cents on every $1,000 of taxable property. San Francisco, huge as it was, would have been cared for by 31.7 cents, while the much discussed billion dollar conflagration, had it occurred in 1921, would have required an assessment of less than twelve cents, about three-seventeenths of the Chicago collection.

The loss by the San Francisco calamity (1906) has also been eliminated for the obvious reason that it was in no sense an ordinary fire loss but the direct result of earthquake; properly a part of the earthquake loss and not separable from it.

Increase in Burnable Property.

Our stock of burnable property has increased at a rate even greater than that of the fire losses, from $29,484,207,200 in 1876 to $265,576,806,320 in 1920. This is an increase of about 900 per cent, compared with 495 per cent increase in the fire loss during the same period. The rate of burning has therefore decreased somewhat, even though total fire losses have been increasing.

In preparing the accompanying tables and curves the values of combustible property are estimated at 80 per cent of the National wealth as given in the U. S. census reports made at 10-year intervals, and increased pro rata between census periods. Probably the actual increase was a fluctuating one but very little error is hazarded in assuming uniform increase. The estimate of combustible property includes imports and exports in transit or storage, moving crops, etc., and appears to be a properly conservative figure which is substantially the same computed by any one of several methods. While this estimate of combustible property is necessarily an approximation, the limits of possible variation are narrow, and even a wide variation in the estimate of burnable property would not modify the general conclusions reached in this article.

The Fire Tax Rate Table below shows the relation of fire loss to total combustible property values by five and ten year periods for both "old style bookkeeping" and "new style bookkeeping."

The ten year period tabulation, at the lower part of the table, gives a clear idea of the trend of the figures, as the effects of fluctuations are so distributed as not to affect the results.

FIRE TAX RATE TABLE.

Period (Inclusive)	Combustible Values (Average)	Fire Losses by Five Year Averages			
		Old Style Bookkeeping		New Style Bookkeeping	
		Average Loss	Tax Rate	Average Loss	Tax Rate
1870-74	$26,000,000,000	$59,000,000†	$2.22	$83,000,000*†	$3.11
1875-79	32,000,000,000	71,000,000	2.23	99,000,000*	3.12
1880-84	38,000,000,000	90,000,000	2.35	126,000,000*	3.29
1885-89	47,000,000,000	113,000,000	2.45	158,000,000*	3.43
1890-94	56,000,000,000	142,000,000	2.55	199,000,000*	3.57
1895-99	65,000,000,000	132,000,000	2.03	185,000,000*	2.84
1900-04	84,000,000,000	172,000,000	2.05	241,000,000*	2.87
1905-09	117,000,000,000	191,000,000†	1.63	267,000,000*†	2.28
1910-14	150,000,000,000	212,000,000	1.41	298,000,000*	1.97
1915-19	222,000,000,000	279,000,000	1.25	390,000,000*	1.75
1920	265,000,000,000	303,000,000	1.15	448,000,000	1.69
1921	280,000,000,000	303,000,000	1.08	485,000,000	1.73
		Ten Year Averages.			
1870-79	$29,000,000,000	$65,000,000†	$2.23	$91,000,000*†	$3.12
1880-89	43,000,000,000	102,000,000	2.40	142,000,000*	3.16
1890-99	61,000,000,000	137,000,000	2.29	192,000,000*	3.21
1900-09	101,000,000,000	182,000,000†	1.89	254,000,000*†	2.65
1910-19	186,000,000,000	249,000,000	1.31	344,000,000*	1.83
1920-21	273,000,000,000	295,000,000	1.08	466,000,000	1.71

*Partly or wholly estimated.
†Conflagrations Chicago, 1871, and San Francisco, 1906, not included.

Fire loss is an actual tax paid as surely and completely as any other tax, and by everyone in strict proportion to his holdings. The collection is inexorable although largely invisible; there is no possibility of evasion or dodging, it is simply collected in full. Stating the proportion of loss in terms of taxes rather than percentages may aid in comprehending the immensity of the evil, for who does not know the commotion aroused in his own community by an advance in the rate of taxation? We may consistently imagine an addition to the published tax rates of each and every town or city of an amount or percentage sufficient to fully make good the fire loss, as merely showing in figures what already exists in fact. It may be well to remember in this connection that insurance pays no losses, it merely distributes them.

Per Capita Losses.

The per capita loss is so frequently stressed that an analysis and comparison with the "fire tax rate" will be of interest. The table below conforms to the U. S. Census except that the increase of 1921 population over 1920 is estimated. The losses are "new style bookkeeping" as used in the preceding table and explained in the text.

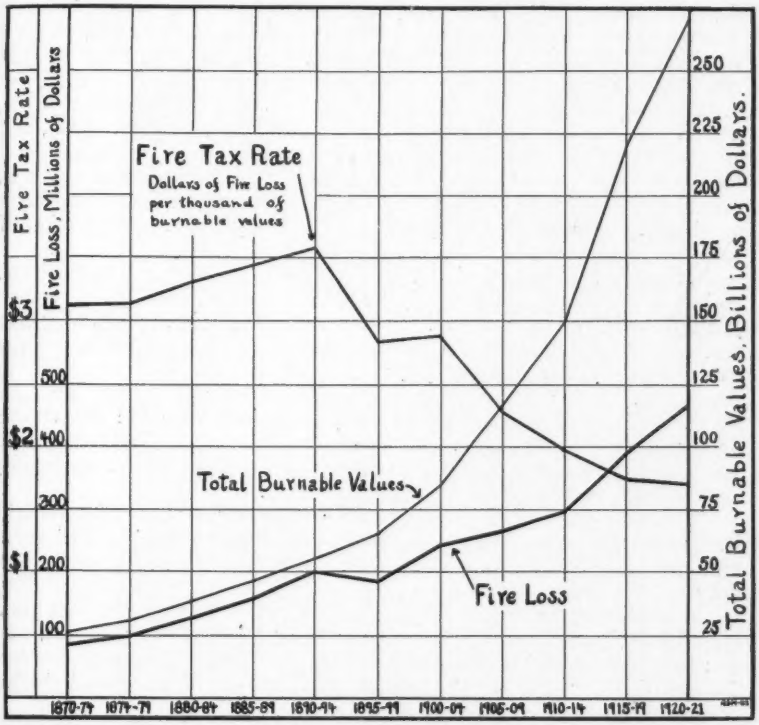
PER CAPITA LOSSES AND THE FIRE TAX RATE.

Date	Population	Combustible Wealth Per Capita	Fire Loss for Year	Per Capita Loss	Fire Tax Rate
1870	39,000,000	$691.00	$72,000,000	$1.87	$3.01
1880	50,000,000	696.00	104,000,000	2.09	3.05
1890	63,000,000	827.50	153,000,000	2.42	3 50
1900	76,000,000	931.50	225,000,000	2.97	2.97
1910	92,000,000	1,491 50	300,000,000	3.26	2.18
1920	106,000,000	2,512.30	448,000,000	4.24	1.69
1921	107,000,000	2,615.00	485,000,000	4.53	1.73

This table shows a steady increase in the per capita loss whether the rate of loss to value ("fire tax rate") is falling or rising. The per capita loss rather closely follows the increases in per capita wealth and amount of fire loss. In point of fact, since 1870 the "fire tax rate" has fallen from $3.01 to $1.73 while the per capita fire loss has increased from $1.87 to $4.53; that is, the rate of fire loss to value exposed has fallen off some 42 per cent, while the per capita fire loss rate in the same period has increased 151 per cent.

Whatever may be the value of per capita loss computations it is clearly evident when used as a means of estimating the comparative fire loss, say of such a country as Italy where the per capita property value is very low, it is apt to be greatly misleading. It may lead us to forget that the average Italian owned in 1920 but about $584 worth of burnable property, as against our average of $2,512.30, and that consequently even if we each burned at precisely the same rate per $1,000 our per capita loss would still be four and a half times as great as his.

A comparison with Great Britain may make this plainer. The British national wealth in 1920 was $120,000,000,000, from which the total of burnable property is estimated to be $96,000,000,000. The population in 1920 was 46,080,000 and the fire loss $37,783,506. This gives a per capita fire loss of 82 cents as against our $4.63, a little less than one-fifth, or to



be more exact, 17.7 per cent of ours, but their fire tax was a trifle over 39 cents per $1,000 or 22.5 per cent of ours, a trifle over one-fifth. England had her object lesson in London in 1666, the United States in Chicago in 1871, so in the matter of fire prevention due to aroused interest Great Britain has two centuries start over North America. But our fire tax has been diminished from its high point over 40 per cent in 27 years, calculating by the conservative ten year averages, and North America is due to, in a measure, overtake its older competitor within the next twenty-five years.

In working for a reduction in fire losses, patience is a prime requisite, for immediate results are not to be expected. Construction betterments, for instance, are cumulative; a very little this year, as much more next, but what is done remains, and at length asserts its influence. There are now probably more than 50,000 automatic sprinkler equipments in operative condition, mainly installed since 1900, to say nothing of increase of fire appliances in number and efficiency, and the growth of interest and understanding.

What reduction has been effected in the loss rate is no more than we could expect, it is not all due to fire prevention effort, for the passing of

the relics of the "boom" and "trust" periods has given it a natural impetus. The maximum rate of loss was in 1893, the year of the panic, in which a veritable epidemic of fire seems to have swept the country. The fire tax rate rose to $4.06 per $1,000, a rate which, had it persisted, would have produced in 1921 an astounding total fire loss of $1,136,800,000. This, and to some degree the abnormal loss rates of 1884, 1891 and 1892, had all the features of an epidemic of disease, and just as the general mortality improves after visitation of pestilence there was a subsequent reaction, presumably due to the wholesale removal of the most conspicuously unfit structures. In none of these years was there any single conflagration of sufficient account to disturb rates.

Now, Mr. Taxpayer, if you have been able to stay with us thus far, go back to the tables and get out your tax receipts, and calculate just what you have paid for the fire loss. Do not attempt evasion by claiming that you are not responsible; only those responsible are called upon to pay the cost. You have already paid your share and will be called on to pay in the future. You are not alone responsible but you cannot escape your share. Do not reckon in what you pay to maintain the fire department or for other fire protection. That is not expense, it is investment. If you have read this record you will realize that and that it is a more profitable investment than average stocks and bonds.

Possibly when you have added all of this to your tax bills you will better appreciate that fire prevention is something more vital than mere sentiment, and that the earnest advocates of prevention and protection are not mere theorists or cranks.

Consider and remember if you can how many times in the past your attention has been directed to some fire hazard within your control, and you have turned an indifferent ear to the complaint. Perhaps no fire has followed in your case but you may be sure that out of a hundred similar cases some disaster would have resulted.

How many flagrantly dangerous conditions or actions on the part of others have you noticed without action?

You may assert that "you are not your brother's keeper," but for each and every such omission where adverse results have followed you have helped to pay. They are all in your fire tax and you have unconsciously but truly paid in full. You are going to pay in the future but can modify the amount by personal alertness and effort, and by putting duty sometimes above inclination and right above expediency.

What is needed is the conscious effort and aid of everyone and an unceasing application of that "Eternal Vigilance," which is the price of liberty and about everything else that is desirable.

The interesting photograph above was received from our member Mr. A. H. Apperson of Richmond, Virginia. The electric heater shown was in the pattern room of a foundry. A workman left a bucket of water to heat at about 6 P. M., and went away. The fire occurred about 3 A. M. It caused a loss of $4500.

Mine Fires and Explosions.

On August 27, 1922, fire broke out in the Argonaut mine in Amador County, California, trapping forty-seven men, all of whom were killed by gas. On November 6, 1922, a gas explosion in the Reilly No. 1 mine near Spangler, Pennsylvania, caused the death of 77 men. On November 22, 1922, a coal dust explosion in Dolomite mine No. 3, near Birmingham, Alabama, caused the death of 84 and the serious injury of 58 miners.

These three very serious recent disasters again call attention to the subject of mine fires and explosions and make a review of timely interest.

The first great mine explosion of the bituminous coal fields of the United States occurred at the Pocahontas mine in West Virginia in March 1884. All the men in the mine, 114 in number, were killed. One hundred and four miners perished in the Kleophas mine, Upper Silesia, Germany, on March 3, 1896, in a fire originating in a shaft which was brick lined, but in which were wooden guides, ladders, etc. Thirty-five men were killed in a colliery fire in Leicestershire, England, on April 19, 1898. In Kanawha County, West Virginia, in December, 1905, seven lives were lost in a drift mine when the timbers near the ventilating furnace took fire. The Courrières disaster in northern France in 1906 took a toll of 1,100 lives.

Although these fires and explosions called attention to the situation, general interest was not awakened until the series of disasters in 1907 when 1,148 men were killed by mine explosions in the United States. The Monongah mine explosion, in West Virginia, which killed 361 men, and the Darr explosion, in Pennsylvania, which killed 239 men, both occurred in December, 1907. These two disasters led Congress to make an appropriation for an investigation of the causes of mine explosions and finally led to the establishment of the Bureau of Mines (July 1, 1910).

Other serious disasters occurred during this period. Fire starting in a box of candles at the foot of a shaft in the Hamsted colliery, near Birmingham, England, on March 4, 1908, caused the death of twenty-five. The disaster at the Cherry, Illinois, mine, November 13, 1909, took its terrible toll of 256 lives when a torch set fire to a load of baled hay used for feeding mules in the underground stables. Fire starting in the wooden floor of an underground engine room in the Pancoast mine at Throop, Pennsylvania, on April 7, 1911, caused the death of 74 miners.

These are some of the more serious coal mine disasters. In the United States alone, during the ten years 1901 to 1910, there were 106 gas and dust explosions in bituminous and sub-bituminous mines that killed five or more men. In these 106 explosions 3,296 men were killed. After the demonstrations in the Bureau of Mines experimental mine at Bruceton, Pa., of the explosibility of coal dust, beginning in 1911, the extent of bituminous mine explosions declined. In the ten years 1911 to

1920, 75 explosions in which five or more men were killed occurred with a total of 2,057 deaths, a reduction of 1,239 in number killed as compared with the preceding ten years, although the average number of miners and the average production had increased nearly one-half.

Loss of life in mine fires has by no means been confined to coal mines, and death has overtaken miners in a number of the metal mine fires. Seventeen lives were lost on February 23, 1911, in the Belmont mine, Nevada, and seven more at the Hartford mine, Michigan, May 4, 1911. In both mines there was a relatively small amount of timber where the fire took place, but this burned out rapidly and produced enough smoke and poisonous gas to cause death.

The Granite Mountain shaft fire, Butte, Montana, June 8, 1917, caused the death of 163 men who were overcome by gas. This fire is reported in detail in Bulletin 188 of the Bureau of Mines recently issued. It is not the general practice of the Bureau to publish reports of individual mine disasters, but the combination of circumstances that resulted in this fire were so unusual and unexpected and the loss of life so great that an exception was made in this case. A brief summary of this report follows:

The Granite Mountain Shaft Fire.

In order to provide better protection against a possible fire in the Granite Mountain shaft the North Butte company, a producer of copper, silver, gold, and zinc, had started to pipe the shaft and place in it at frequent intervals sprinklers, to be controlled by valves from the surface or from various levels. It was decided to place small tanks at intervals of every few hundred feet down the shaft in order to reduce and equalize the pressure. Several of these tanks had been placed, much of the pipe had been installed in the shaft, and the system was practically complete except for the placing of a tank at the 2,600-foot level. The main electrical transforming station was on this level, about 50 feet from the shaft; and partly as a fire prevention measure it was planned to move this station several hundred feet back from the shaft to a place already prepared before the fire, where a minimum of timbering was necessary. The old electric station near the shaft was then to house one of the water equalizing tanks.

Preparatory to moving the electric station, a crew of four electricians, three rope-men, two shaft-men, and one hoist-man early on the morning of June 8, 1917, started to lower 1,200 feet of lead-armored cable into the shaft, to be used in extending the main transmission wire to the newly prepared station. The cable weighed 5 pounds a foot, or 3 tons for the whole. The method used to lower it in the shaft was customary in the district. The rope on the hoisting cage was detached and put in the pipe compartment adjoining, and the cable was lashed to it by 4-foot lengths of hemp rope, placed every 10 feet for the first 500 feet of cable and every 5 feet thereafter. On account of the probability of crushing the cable no positive clamps with bolts were used.

After about 16 hours' continuous work the lower end of the cable had come opposite the 2,600-foot level, and was ready to be taken into it, when the lower 200 feet of the cable was seen to be somewhat coiled around the hoisting rope. In order to remove these twists the hemp

lashings were being removed from about 200 feet of the lower end, when the men noticed that the cable was slipping. The men had scarcely reached safety on the station before the cable fell, tearing away some of the hemp lashings, but slipping most of them and leaving some attached to the rope and some to the cable. This happened at 8 P. M.

In its fall of several hundred feet, the cable struck against the timbers and other obstacles on its way down, and approximately 50 per cent of the lead armor was torn off, which exposed and frayed the oil-impregnated cambric and jute insulation beneath. Of the cross section of the cable, fully half was oil-impregnated, highly flammable material. After an inspection of the cable, the electricians decided that its use as a conductor was at an end, and that the removal of the tangled mass from the shaft would require much time and labor. As it was then almost midnight, and the men had worked continuously for 18 hours, they notified the assistant foreman of the situation and went home.

On account of the failure of the water pipes broken by the fall of the cable, a number of contractors who were drilling in crosscuts below the 3,000-foot level went home early, about 11 P. M., thus probably saving their lives.

At 11.30 P. M. the assistant foreman, a shift boss, and two shaft-men went down on the auxiliary cage to a point 50 feet below the 2,400-foot station to try to find an end of the cable to attach to the cage and so pull it up. The two foremen stood on shaft timbers to see whether an end was available, and in doing this the flame of a hand carbide lamp was brought into close contact with the frayed, oil-soaked insulation. A blaze started immediately, and spread so quickly that it forced the four men to the 2,400-foot station.

Although there were several men on this level, and all took measures to extinguish the fire, the extremely flammable nature of the cable insulation and the dryness of the shaft timbers caused the flames to spread so rapidly that within five minutes of the initial ignition the hot gases had converted the hoisting compartment of the shaft with a velocity of downcast air over 700 feet per minute into an upcast, and rapidly filled the 2,400-foot station with smoke to such an extent that all the men were driven from the station in less than 15 minutes after the fire started.

The 2,000 and 1,800 foot levels of the Granite Mountain shaft were filled with smoke by 12.10 A. M. Doors at the 2,000-foot level were temporarily blocked, and the smoke coming on that station from the hoisting compartment was to a large extent short-circuited, and then entered the main downcasting compartments, flowing into the 2,400, 2,600, 2,800, and 3,000 foot levels. The same short-circuiting took place on the 1,800-foot level. After this happened, distribution of smoke to the lower levels was rapid.

The men were warned of the fire by the smoke and by various foremen. A number escaped through passages to adjoining mines. Two groups of men bulkheaded themselves in the 2,254 and 2,471 crosscuts and all but six were saved. Another group did likewise, but perished. Of 57 men working on upper levels, 32 managed to reach the surface. These were the only men taken out alive during the fire. Those in the bulkheads and other live men were eventually brought to the surface by rescue parties.

The efforts of the entrapped men form an interesting story. A party of 29 men, who bulkheaded themselves in a 2,471-foot level crosscut, kept alive for thirty-six hours. At the end of 24 hours of confinement, neither match nor carbide lamp would burn, although repeated attempts were made to obtain a light. On entering the inclosed region the men had had approximately 9,000 cubic feet of pure air, and the oxygen consumption of 29 men for 36 hours at the minimum figure of 0.9 cubic foot of oxygen per man per hour would be 940 cubic feet or about 10 per cent of total air content, leaving but a little more than 10 per cent of oxygen out of the original 20 per cent. This 10 per cent of oxygen was about the minimum for sustaining life, especially when accompanied by nearly 10 per cent of carbon dioxide, which must have been present. The men kept moving about, stirring up the air, and this accounts for the fact that some were not totally overcome. When the men were rescued they were all suffering from lack of food and water and difficulty in breathing. The men remained behind the bulkhead as long as possible, then broke through and finally reached safety, with the exception of four who took the wrong direction and were overcome by gas.

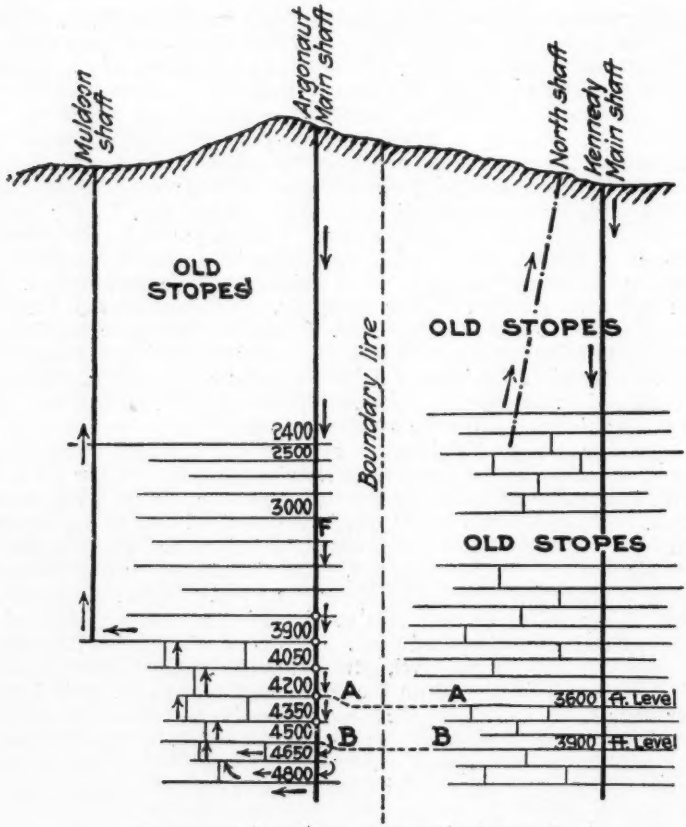
Another group of eight men constructed a bulkhead on the 2,254-foot level crosscut and these men remained imprisoned for 55 hours. When reached by rescuers two were dead and the other six were unconscious. Although sufficient air was in the confined area to support eight men for 65 hours, these men had not moved about and the pure and impure air was not sufficiently mixed. The six rescued men all recovered. Nineteen men tried to bulkhead themselves in a drift on the 2,600-foot level. They failed to take into consideration a manway back of the bulkhead and all were found dead. Two men, after trying to penetrate the fumes on the 700-foot level, retreated to the breast of a comparatively cold but wet drift, turned on the compressed air, pulled their jumpers over their heads and threw themselves face downward on the wet floor with the compressed air blowing close to their heads. From time to time they tried to leave but always encountered gas. Upon failure of the compressed air they left the drift and encountered some rescue men who led them to safety.

Following is the significant conclusion of the report;

> The foremost lesson derived from the Granite Mountain fire is a repetition of a very old one. Hazards unavoidably inherent in underground mining demand eternal vigilance against every form of carelessness. Had the man whose light ignited the cable been more careful the fire would not have occurred. The best efforts of mine owners and managers, of State and Federal authorities, and of organizations to promote industrial safety are unavailing as long as the individual workman is careless. Even had the shaft been entirely fireproof, there seems little doubt but that large loss of life would have resulted from the poisonous fumes generated by the burning of the cable insulation. Every effort to educate underground workmen in the hazards of their work and what should be done to make their operations safe should receive hearty co-operation and support from both employers and employees.

The Argonaut Mine Fire, August 27, 1922.

The Argonaut mine is situated a mile north of Jackson in Amador County, California, about ninety miles northeast of San Francisco, and taps the Mother Lode, a gold-bearing formation that runs along the western slope of the foothills of the Sierra Nevadas. Its workings extend



Section of Argonaut and Kennedy Mines.

These are the principal workings only, projected on a vertical plane. The fire started at point F. The arrows indicate the ventilation and the small circles at the intersections of main shaft and levels indicate doors to stop draft. A-A and B-B indicate the lines of approach for the rescue parties from the Kennedy mine.

to a depth of 4,275 feet, while those of the Kennedy mine, which adjoins it, are carried to a depth of 4,150 feet, part of this difference being due to the fact that the rim of the Argonaut shaft is 112 feet higher than that of the Kennedy owing to the contour of the ground. The main shafts of the two mines are 1,100 feet apart.

The accompanying diagram, which shows the workings of the two mines projected on a vertical plane, will make clear the lay of the land. The main shaft of the Argonaut mine is sunk on an angle, which makes it about 4,885 feet long. The Kennedy shaft is vertical. Each mine has a secondary shaft, that of the Argonaut being designated the Muldoon shaft. This is 450 feet south of the main shaft and has a hoist that can

be operated to a depth of 800 feet only. Below that, the shaft as far as the 3,900-foot level is but a system of offset vertical shafts equipped with ladders. The main shaft is used for hoisting and pumping and by means of it the miners go to and return from their work. Ventilation of the mine is effected by a fan at the Muldoon shaft, which draws the air down through the main shaft, through the workings and out through the Muldoon shaft.

The managements of the Argonaut and Kennedy properties have not been good neighbors. If they had been on friendly terms it is probable that communication between the workings of the two mines would have been maintained with a joint system of ventilation that might have gone far toward averting the serious consequences of the disaster. The latest controversy between them grew out of a fire in the Argonaut workings in March, 1919, which spread into the Kennedy mine through ventilation connections existing at that time. After it had made considerable headway northward into the Kennedy workings it was decided to stop pumping and to allow both mines to flood. That was in March, 1920, since which time they remained under water until April, 1921, when they were unwatered and reopened. Some of the upper workings of the two mines connect or used to do so, but the deep levels do not.

Shortly before midnight of Sunday, August 27, the timbering of the main shaft of the Argonaut was found to be afire near the point marked *F* on the diagram. Communication with those below by means of telephone and electric-bell line is supposed to have been broken by the fire soon after it started, so no signal was given to the miners working at the bottom, chiefly between the 4,800-ft. and the 4,650-ft. level. At first it was thought that the fire could be extinguished before the men would be in serious peril, and by the time their plight was appreciated it was too late. But this was not known until the end.

On Monday and Tuesday efforts were made to extinguish the fire by the use of water from above, but this proved futile. On Thursday it was decided to prevent it from spreading upward by building a bulkhead across the shaft at the 2,400-ft. level, for by that time it had reached nearly to the 2,500-ft. level. Owing to the fact that the Muldoon shaft was charged with smoke and fumes carried from the fire down the main shaft and thence through the mine, none of the imprisoned men were able to escape by that route, and nothing was known concerning their fate.

On the night of Monday, August 28, it was decided to attempt a rescue by establishing communication through the Kennedy mine. Early Tuesday morning the work was started. The fire of 1919 had burned the timbers in those workings nearest to the Argonaut and the admission of water in 1920 caused the ground to cave, filling the levels with mud and broken rock. An effort was made to reach the imprisoned men along two lines of approach; one on the 3,600-ft. level and the other on the 3,900-ft. level of the Kennedy. The lower of these was clear for the greater distance, but to connect it with the Argonaut workings required its being advanced 140 feet through virgin rock. Altogether 475 feet of rock and waste would have to be penetrated. By the 3,600-ft. level the total distance would be 530 feet but the conditions appeared to be more favorable than on the 3,900. The 3,600-ft. drift would have to be extended in two

places through virgin ground for a total distance of 130 feet and would enter the Argonaut at a point 60 feet below the 4,200-ft. level of that mine. Thus the task consisted partly of digging new drifts through debris and partly of blasting a way through rock. In order to hasten the rescue it was arranged to work in 6-hour shifts with gangs of 20 men at each heading, two men working at the face for 20 minutes before being relieved by another pair. With good luck, an advance of 40 feet could be made along a choked drift, and 16 feet could be driven in live rock in 24 hours. The progress of these two attempts to reach the imprisoned men held country-wide attention for three weeks.

Connection was eventually made at 4:55 A. M., September 18, between the 3,600-ft. level of the Kennedy mine and the 4,200-ft. level of the Argonaut, after slightly more than 21 days of work. On the 3,900-ft. level, 86 feet of rock remained to be penetrated. When the men were reached it was found that they had taken refuge in a drift on the 4,350-ft. level, where they had made a vain stand against the fumes. A note, burned by acetylene flame on the mine timbers, indicated that they had perished within four or five hours after midnight on August 27, after having built two bulkheads, using their clothes to make them tight. They had started a third when the gas evidently overcame them.

The Spangler Explosion, November 6, 1922.

The Reilly No. 1 mine is located near Spangler, Pennsylvania. The mine is a shaft opening about 98 feet deep from which the "Lower Kittanning" seam of coal is being mined. All machinery used in the operation of the mine is electrically driven. The explosion occurred about 7:30 Monday morning, November 6, 1922, killing 77 men. It was due to contact of an open light carried by a miner with a body of gas (methane or firedamp). According to a newspaper report the coroner's jury held that the explosion occurred from the use of open lights after the mine management had knowledge of the accumulation of explosive gas in the mine. It was also held that an insufficient number of fire bosses were employed to make proper inspections, and also that proper means for conducting ventilation were not maintained. The explosion involved the inner workings in the immediate vicinity of its origin, but did not extend to the main shafts or other parts of the mine, because of the fact that the mine was wet. If the mine had been dry and dusty, the explosion probably would have been propagated throughout the workings.

The Birmingham Explosion, November 22, 1922.

The coal dust explosion in Dolomite mine No. 3 of the Woodward Iron Company, nine miles from Birmingham, Alabama, killed 84 miners and injured 58 others. The mine is a slope mine and had been operated since 1882 without a serious accident. The slope opens into the side of a hill and, at an angle of 60 degrees, runs 800 feet before reaching the level of the workings. At the foot of the slope is a space where loaded coal cars are assembled and drawn by cable to the surface. A string of these cars broke loose on the incline and dropped to the yard. Great clouds of dust arose with the impact. A high tension cable was severed by the impact and a spark ignited the dust. The full force of the explosion and the accompanying flame went up the slope. The flame was

projected for two hundred feet beyond the mine entrance and set fire to a mine tipple.

The explosion, which came without warning, trapped 480 men in the mine. Most of these were able to reach the surface as the mine was well watered and the explosion was limited, killing only those in the immediate vicinity.

Mine Fire Prevention.

The problems encountered in mine fire prevention and mine fire fighting are entirely apart from those of surface fires. Mine fires originate in many ways and, frequently, from the most unexpected causes. Some of the most common causes are: the ignition of timber, wooden stoppings and brattice* cloths; the ignition of hay or oil soaked materials by open torches; the ignition of coal by blown-out shots, or explosions of fire damp or coal dust, or the improper use of explosives; short circuits of electric currents, due to falls of ground, loosened trolley wires, or poor insulation where wires pass through combustible materials; ignition by friction of oily, wooden rollers on rope haulageways; spontaneous ignition of coal or oily waste; surface fires communicated to the mine through shafts, slopes or tunnels.

The subject of mine fire prevention has been very thoroughly treated by the U. S. Bureau of Mines, both by actual investigation and demonstration work and by a series of educational bulletins on the subject. The work of the Bureau has been of unquestionable value in safeguarding the lives of mine operatives and in educating the mine owner to his responsibility in this connection. It is largely because of this work of the Bureau that the National Fire Protection Association has not devoted more extended effort to the mine fire problem. A N. F. P. A. Committee on Mine Fires, formed in 1910, investigated the subject and decided that the field was already well covered. To quote from one of the Bureau of Mines pamphlets as a conclusion:

> Most of the mine fires that have occurred in open workings could have been quickly and easily extinguished at the beginning had suitable apparatus and men trained in its use been at hand. A considerable proportion of such fires would not be possible if fireproof material were systematically used in underground construction. But at present it is commercially impossible to do away entirely with the use at mines of combustible material like wood timbering. Hence, arrangements should be made to lessen the chance of fires starting, and apparatus should be provided so that if a fire does start it may be put out promptly.
>
> With the exception of explosions, there is nothing that causes such dread among miners as a fire. There is not only danger to life, but also danger of great financial loss. Each year the mining bureaus of almost every mining State report the death of men and the shutdown of mines by fire, and sometimes the permanent loss of the mines and equipment. These fires do not attract public attention unless there is large loss of life.

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Address of D. J. Price to Coal Mining Institute of America, Dec. 14, 1922.

*A brattice is a partition or bulkhead erected for purposes of ventilation.

Dilapidated Building Removal in Boston.

By Charles S. Damrell,
Boston City Building Department.
(Member N. F. P. A.)

The work accomplished by the Building Department of Boston toward removing dilapidated buildings and making the city more safe and cleanly has been most successful. This work will continue until practically all such menaces have been effaced.

This effort has proven of manifold value by removing unsightly structures which were an annoyance to the eye; by removing dilapidated, decayed and rotted structures which were a menace to the health of the city; by removing unsafe buildings and structures which endangered the life and limb of the public; by removing structures which were of no taxable value to the city, clearing the land for building improvements which would add to the revenue of the city and increase not only the taxable valuation of the property itself but also of surrounding estates; by greatly improving, as a whole, the safety, health, value and reputation of the city; by removing from the public mind the fear of danger from fire, disease and injury, occasioned by these structures while standing.

Following is a statement of the number of buildings taken down and estimated cost of taking down same.

Previous to January 1, 1918.....	2321	at a cost of	$283,465
During 1918.....	184	at a cost of	11,499
During 1919.....	257	at a cost of	20,187
During 1920.....	310	at a cost of	40,670
During 1921.....	231	at a cost of	22,000
During 1922 (to November 18).....	152	at a cost of	19,235
	3455		$397,056

Of this amount the city has taken down but 30 buildings at a cost to the city of $919.

In addition, during this time, 1075 buildings have been repaired at a cost of $31,791.62.

The Building Department inspectors report all hazardous and unsafe structures and the Department then obtains authority from the mayor to order the removal of the structure by the owner. In case no owner can be located the building is demolished by the city.

Typical structures which have been removed by the Boston City Building Department as constituting a fire menace.

Highway Bridge Fire Protection.

Report of Coöperative Committee.

During the past few years a number of serious fires have occurred on important bridges and the circumstances attending these fires have indicated the desirability of making a detailed study of the situation, in an attempt to bring out the important factors governing the fire hazard in timber bridge construction. With this purpose in mind a coöperative committee was formed representing fire protection, highway bridge construction, lumber, creosoting, and the public interest, as given by the signatures hereto.

An extensive correspondence has been carried on with city, county and state bridge engineers, and with this and information collected from other available sources as a basis the committee submits the following report.

Fire Risk.

The existence of a fire risk in bridges having wooden floors must be recognized. An indication of the importance of this risk is the fact that on some heavily traveled city bridges small fires are of daily occurrence during the summer months.

The available evidence indicates that this risk is much less for country bridges than for city bridges and is greater on long bridges than on short ones.

Causes of Fires.

On city bridges, fires are most commonly caused by the lodgment of lighted cigar or cigarette stubs in cracks or depressions where chaff and debris have collected. Decayed or splintered material in the floor adds greatly to the fire risk. In the case of country bridges the greatest risk is from forest and grass fires.

Other reported causes of fires are:

Sparks from locomotives or steamboats.

Hot coals dropped by steam rollers, traction engines, tar kettles or other construction equipment.

Burning waste dropped by street cars.

Defective insulation of electric wiring; defective bonding of rails and lack of capacity in return feed wires of electric railways.

Fires in adjacent structures.

Relation of Preservative Treatment to Fire Risk.

Creosoted material appears to be somewhat more difficult to ignite than untreated material, but once ignited it creates a fire which is hotter and more difficult to control and which is known by experience to be more destructive than fire in an untreated floor. However, decayed or partially decayed untreated wood is very easily ignited and has been the

cause of many fires. The likelihood of fire is increased by treatment which results in excessive bleeding of oil, such as might be caused by the heavy treatment of green lumber. It should be noted that freshly creosoted material is much more inflammable than that in which the treatment is several months old. It is urgently recommended that orders for creosoted material be placed as far as possible in advance of construction and that the material be seasoned for from three to six months after treatment.

Where it is practicable to do so, freshly treated timber may be rendered more fire resistant by thoroughly coating the upper surface with sand. The application of sand should be continued as long as there is any bleeding of oil.

Construction.

In general it may be stated that tightly laid floors, in which cracks are eliminated to a large extent, are most fire resistant.

The relative fire risk of various types of floor may be stated as follows, beginning with the most fire resistive:

Wood blocks on concrete base. This type of floor may be said to have no fire risk.

Wood blocks on plank sub-floor.

Laminated floor of 4-inch, 6-inch or 8-inch strips laid on edge and spiked together, with a bituminous wearing surface.

Plank floor with bituminous wearing surface.

Laminated floor without wearing surface.

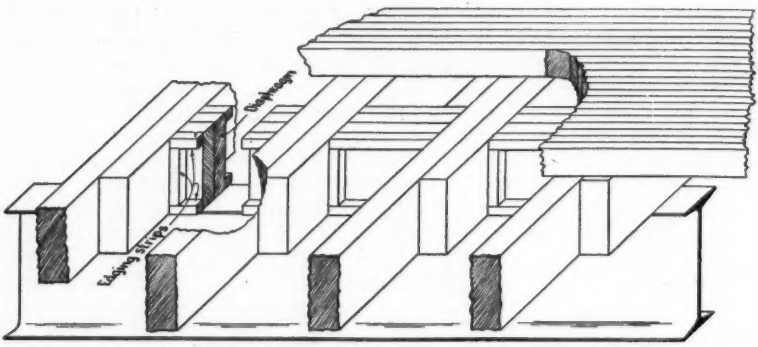
Multiple thickness plank floor.

Single thickness plank floor.

Steel joists or stringers supporting floors of any of the above types reduce the risk of rapid spread of fire by reducing the amount of combustible material exposed. Where wood joists or stringers are used the fire risk will be reduced by using heavy timbers for these members. The massing of combustible material renders it less susceptible to ignition and the spread of fire and lessens the probability of serious structural damage before the fire can be controlled, in case fire-fighting means are at hand.

Special care should be exercised in the design of the floor and its supporting structure to avoid ledges or pockets in which trash may collect. The possibility of the accumulation of rubbish on truss members and in floor openings made for the passage of these members should be given careful consideration. In cases where such construction will not interfere with the proper disposal of floor drainage, curbs on timber floors should be constructed with ample clearance between curb and floor so that trash may have an opportunity to blow away.

To check the spread of fire lengthwise of the bridge, the spaces between stringers, in cases where these rest on the floorbeams, should be filled with tightly fitting diaphragms over each floorbeam. Perhaps the most practicable method is to use wooden diaphragms at least six inches thick, which may be made up of two thicknesses of plank spiked together. Strips or battons should be placed around the edges of these diaphragms to cover cracks due to imperfect fitting or shrinkage. The accompanying sketch indicates the recommended construction.



Sketch of fire stop diaphragms over floor beams.

In cases where limitation of headroom is not a factor, fire curtains of sheet metal extending at least five feet below the bottoms of the joists, and spaced at intervals of about 50 feet, will be of material assistance in preventing the spread of fire. The corrugated asbestos-covered metal as used for siding and roofing of buildings is suggested for this purpose.

Maintenance.

Floors, ledges and pockets, and bridge seats should be kept free from street sweepings and other trash.

In the case of country bridges, particularly timber trestles, all underbrush, small timber, drift and debris, underneath and for some distance on both sides of the bridge should be removed. Grass and weeds should be cut in the early fall and drift should be removed after floods. Where the vegetable growth is heavy, chemical weed killers are recommended as being economical and efficient.

Frequent inspections should be made of any conductors of electricity which may exist on the bridge.

Floors should be kept free from splintered and decayed wood.

Provisions for Fire Fighting.

For bridges where watchmen or bridge tenders are employed, water barrels, sand boxes or water mains may be employed to advantage for fighting fires. For bridges not under constant supervision the value of any of the above is questionable, although sand boxes would probably be most likely to be ready for use when needed.

Water barrels and sand boxes should be covered and the surface of the water in the barrels should be covered with a light film of oil.

In cold climates freezing of the water in barrels can be prevented by the addition of a suitable amount of calcium chloride.

When water mains are provided they should have hose connections every 50 feet and hose reels every 200 feet. In cold climates they must either be protected against freezing or be kept empty with provisions for supplying them with water under pressure, either from hydrants direct or from fire engines.

Watchmen and drawbridge tenders should be provided with at least one 2½ gallon soda-acid fire extinguisher. Where aid may be expected from a municipal fire department, there should be provided some means of transmitting alarms. If watchmen or bridge tenders are on duty, a telephone may be considered as a substitute for the more reliable and satisfactory public box on a fire alarm telegraph system.

Maintenance of the understructure and the use of fire fighting appliances will be facilitated by providing under the bridge floor, on each side of each pier and at intermediate points not more than 100 feet apart, platforms constructed of fire resistive material. Access to these platforms may be secured either by hatchways in the bridge deck or by stairs on the outside of the bridge.

In cases where fire streams from hose and nozzles are available, there should also be provided at 20-foot intervals, both longitudinally and transversely, openings in the bridge deck to permit the use of cellar pipes, revolving nozzles or similar devices. These openings should be not less than 10 inches in diameter and should be provided with metal covers which can be easily removed but not readily displaced by accident.

Fire Retardant Paints or Treatment.

The weight of the evidence, obtained from laboratories which have investigated this subject, is to the effect that, whatever may be expected from future experimentation, there is at present little that can be accomplished in the way of rendering wood fire resistive by means of a paint coating or other treatment by chemical methods. A paint coating which is not readily combustible may, however, serve to delay slightly the time in which the lumber reaches its maximum susceptibility to ignition. The difficulty with the chemical treatment is that the chemicals will either wash out or, if waterproof, are not fire resistive.

Conclusion.

The investigation having shown that the subject of bridge fire protection is of an importance not previously recognized, the committee desires to emphasize the need for giving consideration to the fire risk in the design of highway bridges. Public officials having bridges in their charge have a clear responsibility in the matter, and the committee desires to call to the attention of such authorities the desirability of protecting bridges by due care in design and construction, by watchful maintenance, and by provision for preventing and fighting fires.

Committee.

Chairman, Geo. W. Booth, Chief Engineer, National Board of Fire Underwriters.
L. T. Ericson, Chief Engineer, The Jennison-Wright Company.
C. M. Taylor, Past President, American Wood Preservers' Association.
D. F. Holtman, Construction Engineer, National Lumber Manufacturers' Association.
C. J. Hogue, Manager, West Coast Forest Products Bureau.
F. E. Schmitt, Associate Editor, Engineering News-Record.
Secretary, E. F. Kelley, Senior Highway Bridge Engineer, U. S. Bureau of Public Roads.

A New Foam for Oil Storage Protection.*

At the December meeting of the American Petroleum Institute (member N. F. P. A.) at St. Louis, Mr. J. M. Jennings, of the Development Department of the Standard Oil Company of New Jersey, delivered an address on "Sealite," a "gaseous emulsion" or foam developed by the Standard Oil Company for the purpose of retardation of evaporation from the surface of crude oil or gasoline in storage. This new substance promises to be of great interest, for while it has been developed and presumably will be used primarily to prevent the loss of valuable salable oil, it should incidentally very greatly reduce the fire hazard of oil storage both by decreasing the amount of explosive vapors given off and by acting as a smothering blanket in much the same way as the ordinary fire foam protection, to extinguish any fire which may start on the surface of the oil. This is a very interesting instance of a development primarily for a commercial purpose incidentally improving fire hazard conditions.

The loss of the lighter, more valuable, constituents of crude oil and gasoline is shown to be very large and represents a very considerable money value, according to the United States Bureau of Mines in the survey just published in its bulletin No. 200. The results of this study generally confirm the records made by some of the larger oil companies on the same question. It appears to be conclusively shown from all the investigation which has been made that the "evaporation" loss on gasoline of about 58° Bé. will average very close to ½ of 1 per cent per month throughout the year when the stock is stored in the best steel tankage of the standard type, that is, 90 to 120 foot tanks with steel roof or wooden roof covered with tin, carefully fastened at the eaves and weather-tight throughout, but provided with the necessary vent openings.

In similar tankage, average domestic crude oil, Mid-Continent, Texas, California or Pennsylvania, running from 20 to 30 per cent natural naphtha of 58-60 Bé. gravity, is found to lose about 3 per cent by volume during the first year of storage and 2 per cent during the second year. On especially light crude oil much faster evaporation rates are recorded.

Translating these figures into terms of volumetric and financial loss gives the following results:

Yearly loss (first year) on 55,000 bbl. tank of crude = 1650 bbls. @ 10 cents per gal. = $6930.

Yearly loss (first year) on 88,000 bbl. tank of crude = 2640 bbls. @ 10 cents per gal. = $10,088.

Yearly loss on 55,000 bbl. tank of finished gasoline = 3300 bbls. @ 15 cents per gal. = $20,790.

Yearly loss on 88,000 bbl. tank of finished gasoline = 5280 bbls. @ 15 cents per gal. = $30,264.

* Extracted from the complete text of the address as published in the *National Petroleum News.*

The figure of 10 cents per gallon for the gasoline content of crude oil and 15 cents per gallon for the finished gasoline are, of course, attempts to strike an average between widely fluctuating prices.

Since the evaporation loss on crude oil is made up in effect entirely of the gasoline constituents thereof, mainly the lighter gasoline constituents, the true economic loss is given by the above calculation, regardless of whether this loss is sustained directly by the owner of the crude or in part by the refiner who subsequently fails to recover from it the gasoline lost during storage.

The greatest loss from evaporation occurs very naturally during the summer, but the records show that the loss during the winter is more than one-half the loss during the summer. The evaporation problem is, therefore, an all year around one.

In addition to the evaporation loss, it is claimed that a very large saving in fire loss can be effected by the use of "Sealite." If average fire losses are estimated on the basis of insurance premiums, 1 per cent of the total value of the oil stored is a fair annual average proportion of the fire loss for any given tank.

Evaporation and Fire Losses.

Evaporation from the surface of oil in storage depends on temperature, atmospheric pressure, and movement of air over the oil surface. High temperatures, such as are reached in summer when tanks are directly exposed to the sun, of course promote rapid evaporation. With changes of temperature there is "breathing" through the vents, thus charging the air and increasing evaporation. Diffusion and "windage" also contribute towards evaporation. In the past many methods, none entirely efficient, have been used for retardation of evaporation. These include pressure tanks connected with gasometers, gas tight vented tanks, protected tanks with water sprayed roofs, shaded tanks, insulated tanks, etc. Commenting on the gas tight vented tanks, in which class falls the type of storage recommended by N. F. P. A. regulations, Mr. Jennings said:

> This type of tankage (large storage tanks) may be either wood or steel roofed and is of standard construction save that special pains are taken to stop air leakage at the eaves, roof seams and hatches. Some of these tanks may be really gas tight but this condition is not easy either to get or maintain on 90 to 120 foot tanks with anything save standard gasometer domed-roof construction.
>
> To the extent to which the tank approaches perfection the diffusion and windage loss is reduced, but the other losses remain. Some of the gas tight tanks are equipped with double-valved breathers, some with standard screened vent pipes. From a fire hazard standpoint, the "gas tight" vented tank does not eliminate the possibility of the explosive mixture, although its proponents believe it greatly reduces the chance of such a mixture being accidentally ignited. So far as such ignition takes place from the outside this must be so. Unfortunately there is not sufficient reliable data available to reach any conclusion on the exact reduction of fire risk. An objection to this type of tankage is that the roof being tightly riveted or welded at the eaves and of stout construction, is a serious menace to the safety of surrounding tankage or other property in the event of an internal explosion.
>
> Such an explosion no longer finds easy relief upward and may result in rupturing the tank wall and spilling the oil at the same time that it is fired. This possibility has greatly retarded the more general adoption of tightly riveted or welded roofs.

The whole subject of fire hazard is obviously very closely related to that of evaporation. Reduction of evaporation means that explosive gases are given off in less volume, and that the liability of ignition is reduced. On the subject of causes of fire losses, Mr. Jennings said:

In order that a tank of oil may burn, it is obviously necessary that the air be permitted to get at the oil surface more or less freely. The sole defense is the roof; if that is ruptured, burned, or blown off, the tank is free to burn until it is pumped out or the fire extinguished by smothering with steam or foam.

Probably the most common single cause of roof failure and resultant fire is lightning. This may be either the direct rupture, demolition, or burning of the roof by a lightning bolt, or it may be due to ignition of an explosive mixture within the top of the tank by a chance spark of electrical or mechanical or chemical origin and of infinitesimal proportions, resulting in the roof or a portion thereof being blown off. "Lightning" usually gets the credit for such explosions, and is in no position to disclaim the honor, but proof that mechanical or chemical agencies do not contribute to the total losses is lacking.

With regard to the possibility of existence of an explosive mixture within the tank ready to be set off by a chance spark of whatever origin, there is some misunderstanding. It is often assumed that the nature of the mixture is definitely fixed by the vapor pressure of the oil. This is so only in one direction. If the vapor pressure is really too low to support an explosive mixture, then it is not apparent how such a mixture can exist, but the fact that it is so high as to theoretically give an over-rich and therefore non-explosive mixture is not a practical answer, as is abundantly proved by experience. The reasons are as follows:

1. There is a relatively long time interval necessary to establish full equilibrium vapor pressure, and the rate of change of the air in the tank from breathing, diffusion, or windage, may outstrip the evaporation rate of oil.

2. Even where the excess vapor pressure overcomes this lead, and the mixture in the tank is found to be too rich to explode under ordinary conditions, rapid breathing (inhalation) which is the very condition almost universally met with in the case of electrical storms, may result in stratification of the air in the tank, giving a more or less large intermediate zone in which the mixture is of perfect explosive proportions.

The New "Gaseous Emulsion."

"Sealite," which has been under development and tested by the Standard Oil Company for several years, has as its principal constituents, glucose, corn starch, glycerin, calcium chloride, glue and air. It weighs 4.75 pounds per gallon, being light enough to float on the lightest gasoline. It is stated that when dumped on the surface of a tank of oil in sufficient quantity to make a covering about one inch thick it forms a perfect seal at a cost for the material of from 30 to 50 cents a gallon applied to the tank. This makes the cost of the protection from 3 to 5 cents a barrel of oil protected. According to experiments where oil is not pumped in and out of the tank the life of the material is about one year. At the average yearly rate of evaporation loss this protection is said to pay for itself on bulk gasoline storage in from one to two months.

Describing the theory of the application of the material and the fire tests made on it, Mr. Jennings said:

As applied to oil containing volatile constituents, in bulk storage in tankage vented to the atmosphere either directly or through breather valves, "Sealite" has two functions to perform. The first of these is to prevent contact between the oil and the air and the second is to insulate the oil surface against sun radiation transmitted through the roof. To the extent that it performs these functions, the stored oil is protected against all "evaporation"

loss "save that due to the escape of excess permanent gas" and is likewise protected against fire.

It is found that the "Sealite" does perform these functions when applied to a tank at a temperature above 25 degrees F., giving it an opportunity to flow over and seal the surface of the oil. Oil thus sealed and containing no "wild gas" (which can only be held in by substantial pressure) shows no loss of volume or weight under the most careful tests made by weighing and gaging protected vessels over periods of several months.

The insulating effect of a layer of "Sealite" much less than one inch in thickness is shown to be ample to prevent the surface film of the oil from reaching any temperature substantially above that of the oil body itself, i. e., a maximum of about 90° F., in the latitudes of the Mid-Continent field of the United States.

On the question of fire prevention, it has been shown to be impossible either to initiate or to maintain a fire in an experimental tank the surface of which is covered with "Sealite." As to initiating a fire, it is obviously impossible to ignite the "Sealite" itself, and in the normal condition of the tankage, it is the only thing exposed to be ignited. Experimental tanks of crude oil and gasoline have been filled with an explosive mixture, the mixture ignited and the roof blown off, for the purpose of seeing what effect this would have on the "Sealite."

No effect was observed, the "Sealite" remaining entirely unaffected either in appearance or properties by explosions of this kind. On the basis of this experimental evidence, therefore, it does not seem possible to initiate a fire in a tank having this protection. Consideration must be given, however, to the possibility of disturbances of the oil through demolition or burning of the roof or other unforeseeable causes which would destroy the protection. To duplicate these conditions, on a limited scale, various tests have been carried out on experimental tankage. These tests have been of three kinds:

1. Building bonfires of light materials, such as shavings, paper and light wood sticks on the top of the "Sealite" coating. Such bonfires burn for only a sufficient length of time to raise the "Sealite" to the temperature at which its viscosity is no longer sufficient to support the load of the burning material. The burning mass then sinks through into the oil, leaving a hole which burns momentarily until the "Sealite" flows over it, immediately extinguishing the fire.

2. Pouring oil over the surface of the "Sealite" or stirring the "Sealite" up in the oil. By either of these methods the top surface of the "Sealite" may be covered with oil, which will mostly exist as a mere surface film but occasionally in tiny pockets one-quarter of an inch in depth or thereabouts. When this oil is set on fire, it burns freely until the film has been burned off, usually less than one minute. The tiny pockets scattered over the surface burn somewhat longer but extinguish themselves in two or three minutes either by exhaustion of the oil, or by reducing the viscosity of the "Sealite" to such a point that the few remaining drops of oil fall through the "Sealite" layer, which closes over them and extinguishes the fire in this way.

3. Sweeping away the "Sealite" from portions of the surface and igniting the exposed oil. Fires started in this way are extinguished by the return flow of the "Sealite," which advances slowly across the exposed surfaces from the margins, until the wounds are completely healed and the fire thereby put out. This smothering process is accelerated by the reduction of viscosity in the "Sealite" through heat generated by the fire.

On the basis of the test data obtained in these experimental tank fires, it therefore appears that when a tank is protected by a normal coating of "Sealite," no fire can be either initiated or maintained. Where the protection is removed by disturbances of the surface, it appears that the "Sealite" has to a remarkable degree an automatic and highly effective action in healing its own wounds and thereby extinguishing fires of limited extent, which might be started in this manner.

The "Sealite" has certain limitations which need not be detailed here. The most important of these seems to be that the life of the material is much shortened by agitation such as would be involved when used on the

surface of a tank where the oil was being pumped in and out at frequent intervals, and that consequently at the present stage of development the protection does not seem applicable to refinery or other tankage where there is frequent pumping. Another limitation is that the material is soluble in water, and that it could not be maintained under a leaky roof. An additional point to be noted is that "Sealite" only prevents evaporation of liquids; it does not confine dissolved or "wild" gas.

"Sealite" has been under field test for two and one-half years. Commercial use on an extensive scale was first begun in March of the present year in the refineries of the Standard Oil Co. (New Jersey). Gagings of the most accurate possible correctness have been made on a series of identical gasoline storage tanks with and without "Sealite" protection and with various grades of gasoline. These results show the total storage losses on three standard 93 x 35 ft. steel-roofed tanks. The tanks contained three representative grades of domestic motor gasoline, averaging about 59° Bé., but having detailed specifications somewhat different owing to the use of different representative methods of manufacture. The curve of storage losses without "Sealite" protection on these three tanks was obtained between March 20 and August 8, 1921, while the curve for each tank showing losses with "Sealite" protection was obtained during the same period of 1922.

One of the tanks apparently had a greater amount of seam leakage than the other two tanks; but since all three were apparently representative standard tanks in good condition, the averaged result may be taken as fairly representative. These curves show that during the 140 days the three "Sealite" protected tanks lost 24,945 gals., while the same three tanks unprotected lost 117,800 gals. The "Sealite," therefore, saved approximately 80 per cent of the normal total loss. The remaining 20 per cent of the total loss not prevented by "Sealite" may have come from two sources, i. e., seam leakage and escape of excess permanent gas. It is impossible to estimate accurately how much of the unprevented loss was due to each of these causes.

Up to the present time, "Sealite" protection has been applied to some 2,500,000 bbls. of stored gasoline, and approximately an equal amount of stored light crude, by the following companies: Standard Oil Company (New Jersey), Standard Oil Co. of Louisiana and Humble Oil & Refining Company.

Heat Penetration Through Sand Protection.

Investigation of Cause of Fire on U. S. Treasury Building Roof.*

A fire on the platform of the blue printing gallery on the roof of the U. S. Treasury building on February 8, 1922, was caused by the pitch heating equipment of the contractor for alterations and repairs of the roof. This fire did considerable damage to the temporary structures on the roof and a great deal of inconvenience to the Drafting Division of the Supervising Architect.

Fig. 1. Damage by the fire on the U. S. Treasury building roof May 3, 1922. This fire was caused by an oil burner used for heating roofing cement, as shown by tests of heat penetration through the protection used.

After placing what was thought to be ample protection for the wood floor of the gallery, the apparatus was again put into use. At 1.45 A. M. on the morning of May 3 fire was found burning under the platform

* The results of this investigation are made available through the courtesy of officials of the Treasury Department and the Director of the Bureau of Standards of the U. S. Department of Commerce. The experimental work reported here was done by Mr. N. D. Mitchell, of the Bureau of Standards.

and in the printing gallery. Both were a total loss. (See Fig. 1.) This second fire did damage to the extent of $6000 and incidental inconvenience and loss amounting to more than the money value of the damage.

The burner used for heating the slater's cement was thought by the Fire Marshal to have caused the fire and at the request of the committee appointed by the Secretary of the Treasury to determine the cause of the fire the Bureau of Standards made an investigation of heat transmission through such protection as had been used on the floor.

The Test Equipment.

The equipment and conditions involved in the fire were duplicated as nearly as possible in the tests. The original burner which had been damaged in the fire was repaired for use in the test, but this failed on the second day of the tests. A new kerosene oil burner of the identical size and type was then purchased and used for the other tests. Oil was supplied to the burner under pressures of from 40 to 60 lbs. per sq. in. from a ten gallon pressure tank. A workman who assisted in making the original floor and installing the burner helped construct the test floor and covering and set up the apparatus.

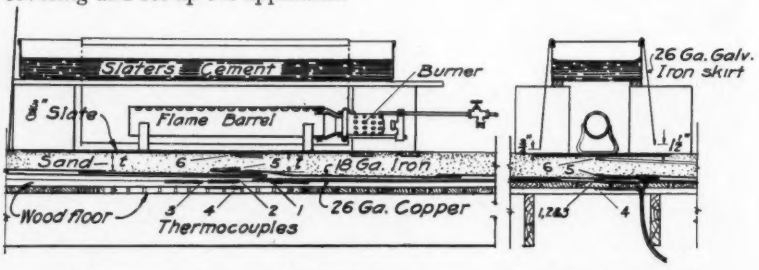


Fig. 2. Apparatus for Heat Penetration Tests, as set up to reproduce the equipment which caused the fire.

The details of the apparatus are shown in Fig. 2. This was a wooden floor built to represent the Treasury Building roof, with metal, sand and slate protection under the burner. The thickness of sand used with the original contractor's equipment was thought to be three to four inches, but as this was not definitely known, the thickness of the sand bed was varied in the several tests. Thermocouples were located in and below the protective covering, for determining the temperatures at the several points. The tests were run for periods of about eight hours to simulate an eight hour working day.

The test floor was made of dry yellow pine. The joists were 2x10 in. spaced 22 in. apart, on which was laid a slat floor of 2½x⅞ in. strips placed ¼ in. apart. A top floor of 6x⅞ in. matched sheathing laid with ¼ to ½ in. open joints was laid across the slat floor. The protection for the wood floor as shown in Fig. 2 consisted of sheets of No. 26 gauge copper lapped about one inch at edges; on this was placed a layer of No. 18 gauge galvanized iron sheets lapped from one inch to 4 inches at the edges. The thickness of the sand protection ("t" Fig. 2) on the top

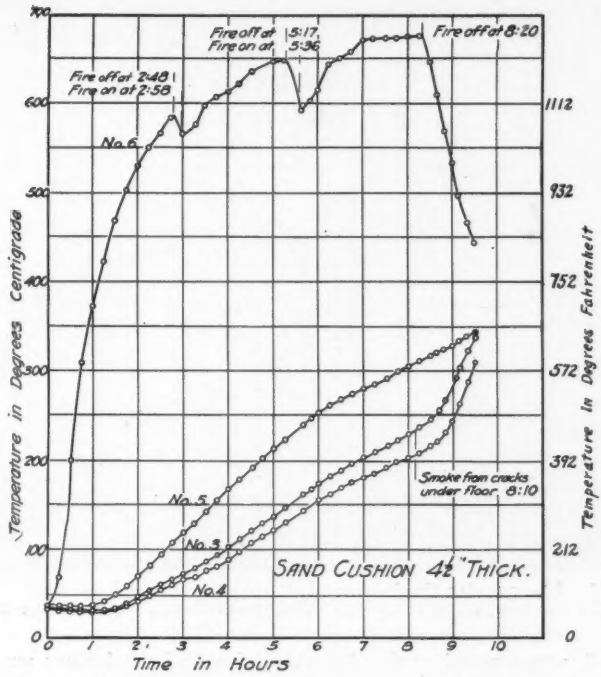


Fig. 3. Temperatures at various points in sand bed and on floor under the burner with 4½ in. sand cushion.

of the iron sheets was varied for the different tests from 2½ in. in the first tests to 3½ in. for the second series, 4½ in. for the third series and 6 in. for the fourth series. On top of the sand a layer of slates ⅜ in. thick was laid down and on the layer of slates the burner was set. The slates were used only directly under the pan; the sand protection extended with reduced thickness, for several feet beyond in all directions. The pan for slaters' cement rested on iron bars laid on four hollow terra cotta tiles at the corners, its bottom being about 4 inches above the top of the flame barrel which had holes near the top to allow the flames to bathe the bottom of the pan. An open shed roof over the floor protected it from rain.

The arrangement of the iron-constantan thermo-couples for measuring the temperatures in the different parts of the protecting covering and on the floor boards, both upper and lower layers, is shown in the drawing.

Tests with Different Thicknesses of Sand Cushion.

The old burner was set up on a protecting covering in which the sand thickness was 2½ in. The first day the temperature on the top of the wooden floor at thermocouple No. 2 was 200° C. (392° F. at 8¼ hours after the start. On the second day a temperature of 180° C.

Fig. 4. Floor under the burner after the test with 4½ in. sand cushion. (See Fig. 3 for temperature curves.) The wires shown were for the thermo-couples.

(356° F.) was reached at 6½ hours. Failure of the burner prevented further satisfactory operation.

The new burner was set on the protecting covering with 2½ in. sand cushion. Interruptions of more than an hour during the first two days runs made them unsatisfactory. The maximum temperatures on the floor boards for these two days were 259° C. (498° F.) and 270° C. (518° F.). No fire resulted.

It was realized that with several repetitions of the heating of the floor to temperatures reached in the previous tests that charcoal would be formed. To avoid the large number of repetitions of the heating, and since further it was known that the lower layer of boards of the floor on which the apparatus had been set at the Treasury Building had been charred in a previous fire, and that considerable quantities of powdered charcoal must have existed by reason of the workmen walking over this floor, it was decided to introduce a small amount of this material. Accordingly, on the third day about an ounce of finely powdered charcoal was blown through the cracks of the floor so as to lodge on the boards. At 5 hours and 23 minutes after the start of the next test a fire was seen to be burning through the floor, which had apparently been present an hour before it was discovered as determined from the rise of temperature at one of the thermo-couple points.

For the test with the thickness of the sand cushion increased to 3½ in. the apparatus was moved about 12 in. to the side of the first

location. A small amount of powdered charcoal was spread on the floor before the protecting courses were laid. At 5 hours and 12 minutes smoke was first seen coming from the cracks in the floor and the burner was shut off. One hour and 43 minutes afterwards the smouldering fire burst into flame. The temperature curves indicated ignition to have taken place about one hour before smoke was seen. The boards of the upper floor were thoroughly charred for a space 18 by 24 inches.

The floor was patched with seasoned pine boards and the apparatus moved to a new place on the floor. The powdered charcoal was applied quite thinly on the floor. The protection courses had a 4½ in. sand cushion, otherwise conditions were the same as before. Smoke appeared in the cracks of the floor in 8 hours and 10 minutes, the temperature at thermocouple No. 3 being at this time 234° C. (453° F.). The fire was allowed to smoulder for 1 hour and 20 minutes. It did not blaze up. Fig. 3 shows the temperature at four of the thermo-couples during this test.

The test with the sand cushion of 6 in. was continued for two days. The fire in the burner was kept up for 8 hours and 32 minutes the first day, and for 8 hours and 15 minutes the second day. The maximum temperature recorded at thermocouple No. 2, 175° C. (347° F.), was reached 3 hours and 15 minutes after the oil was shut off on the second day. The floor boards were charred considerably from the effects of the heat, but no ignition resulted with this thickness of sand, although the temperatures attained on the wood indicated possibility of ignition with greater number of repetitions of heating.

Conclusions.

These tests show that this type of protection is inadequate for the purpose used, and lead to the conclusion that even with six inches of sand under the burner, the floor was not safe against ignition. It is obvious that even with temporary heating apparatus of this type much more substantial floor protection should be provided. An arrangement to provide proper air circulation between the protecting course and the wood would be a simple method of insuring the safety of this type of heating device.

Interested in Fires.

(From the Wellington Enterprise.)

Special request: All citizens not members of the fire department should stay off the fire truck when it is responding to an alarm. At a recent fire so many outside people got on the truck that the regular firemen had to walk to the fire.

Fireproofing Wood for Theatre Scenery.*

By André Kling and Daniel Florentin, of the Paris Municipal Laboratory.

In the work which we have already mentioned (QUARTERLY, October, 1922, p. 134) Gay-Lussac says that "it is scarcely necessary to remark that wood, burning much less freely than fabric, requires much less salt impregnation to render it incombustible."

Gay-Lussac's statements do not seem to be based on experiments and he appears not to have stated the problem exactly, for while it is true that large pieces of wood are ignited with comparative difficulty, it is no less true that the protection of their surfaces by means of fireproofing solutions does not appreciably change their combustibility.

And, on the contrary, thin wood, from 10 to 20 millimeters (⅜ to ¾ in.) in thickness, especially rough wood such as is generally used in the construction of theatre scenery, is very inflammable. Also it is highly desirable to make it, if not incombustible, at least non-flammable.

For a long time there have been two processes recognized for accomplishing this, as follows:

1. One process consists, as proposed by Gay-Lussac, in covering the surface of the wood with a suitable salt. By this method fabrics may be made really non-flammable, almost incombustible, but with wood a simple coating will not do much more than slightly delay ignition. This is because the mass of the wood when subjected to a sufficient temperature is decomposed and gives off a combustible gas which goes through the protective coating and burns on contact with the air, thus progressively increasing the temperature and rate of distillation of the gas.

It is, therefore, necessary to assure real protection for wood to have the protective layer relatively very thick in comparison with the thickness of the wood protected.

2. The other method is to coat the surface of each fibre of the wood with a protective layer. To accomplish this it is necessary that the fireproofing solution thoroughly penetrate the entire mass of the wood, by means of suitable processes.

By this method, in some cases, it is possible to make the treated wood almost incombustible, as proposed by Gay-Lussac; that is, it may carbonize but will not burn with flame. Unfortunately the application of this

* NOTE:—This article appeared originally in the March 4, 1922, issue of *Genié Civil* and is published with permission of the editor. Translation by the Executive Office of the N. F. P. A.

This work by our French contemporaries is of great interest but should not lead us to overestimate the value of this kind of fireproofing or to forget the fact that no fireproofing treatment can make wood "fireproof." For results of N. F. P. A. committee work on the inflammability of wood treated with fire retarding compounds see *Proceedings* 1915 (vol. 19, p. 106). This report has also been reprinted in pamphlet form and is obtainable from the Executive Office on request; refer to No. D37.—ED.

process is expensive. Moreover, wood so treated is heavy and very difficult to work, so it would be unreasonable to require its exclusive use in theatres.

Comparison of Various Fireproofing Solutions.

We therefore confined our researches to the process of surface fireproofing, the practicable process, with the object of determining the most efficient of the several salts proposed for fireproofing purposes.

In the absence of proper comparative data, it was in general necessary to be content with a determination of the effectiveness of each of the several salts, without attempting to classify them according to relative merits. It was also necessary to limit the tests to woods of the same species and characteristics in testing the various mixtures and solutions of varying concentrations.

The test pieces were prepared by cutting from the same poplar and pine planks, a series of rectangular pieces of the same size about 0.5 cm. (3/16 in.) in thickness. The several test pieces were treated on both sides with the various fireproofing mixtures, one being left untreated as a basis of comparison in each case. The test pieces were then dried; when thoroughly dry the tests were started.

We used a special blow torch which had been used for determining the inflammability of theatre decorations. The test pieces were placed in a vertical plane. The blow torch, the length of flame being kept as uniform as possible throughout the duration of the tests, was directed against one side of the test piece, with the end of the interior blue core of the flame exactly in contact with the surface of the wood. The time was noted when the first flame appeared on the opposite surface. The dimensions of the surfaces burned during equal times were noted, also the behavior of the secondary flame resulting from the burning of the gas distilled from the wood.

In the first series of tests the obvious inferiority of several salts was shown. These were eliminated and only the following retained for the final tests: Ammonium sulphate, boric acid and borax, sodium silicate, ammonium phosphate, ammonium chloride. With each one of these salts we prepared solutions of increasing concentrations. We increased the viscosity, when the solutions were not of themselves sufficiently viscous, by the addition of gelatine or glue, in order to increase the amount of solution retained on the surface of the wood. The solutions were applied in one or two coats.

The conclusions drawn from these comparative tests are as follows:

1. Volatile ammonium salts have low efficiency.
2. The salts which can give real protection are those which on heating fuse to form a protecting glaze.
3. Among these ammonium phosphate is the most efficient. A solution containing 250 gms. of this salt per liter (1 lb. 14 oz. per gal.) thickened by the addition of 10 gms. (1.2 oz. per gal.) of gelatine or glue, and applied in two successive coats on the surface of the wood, gives efficient protection.
4. Mixtures of several salts do not seem desirable (with the exception of the borax and boric acid mixture).
5. The addition of powdered asbestos to fireproofing solutions, particularly those of ammonium phosphate, does not increase their fireproofing value; the only advantage is that by coloring the fireproofing coating white any abrasion or disintegration of the coating, caused by handling or working the wood, is readily apparent.

6. Mineral substances such as barium sulphate or similar salts introduced into or precipitated in the solution have the same effect as asbestos, with the exception that on account of their high density, it is difficult to maintain them uniformly in suspension in the solution with the result that the intensity of the color of the solution does not permit of properly estimating the quantity of the fireproofing material deposited on the surface to be protected.

The conclusion which we reached is that for surface fireproofing of wood, the best method consists of applying to the surface two coats of the following mixture:

Ammonium phosphate $(NH_4)_2 HPO_4$	250 grams	1 lb. 14 oz.
Gelatine or glue	10 grams	1.2 oz.
Powdered asbestos (optional)	400 grams	3 lbs.
Water	1000 grams	1 gal.

The quantity of salt deposited, of course, varies with the character of the surface of the wood, but in our tests it required on the average six-tenths of a liter of the solution per square meter (about 1 pint per square yard). The cost of the materials on this basis is approximately one franc per square meter (1 sq. meter = 1.2 sq. yds.) for the solution without asbestos and two francs for the solution containing asbestos.

Fireproofing of Wood Exposed to the Weather.

FIREPROOFING BY MEANS OF SALTS. Although in theatres wooden scenery is not normally exposed to rain, a problem frequently encountered is the fireproofing of wood used in temporary exposition construction.

For the tests of wood exposed to the weather, test pieces of pine and poplar about 10 millimeters (⅜ in.) in thickness were used. These planks were treated with one or two coats of the ammonium phosphate fireproofing solution described above, with and without the powdered asbestos.

The treated planks were well dried, then coated, one with a cellulose acetate varnish, the other with an ordinary linseed oil paint. The test pieces were then left in the open air for two months, in the winter.

At the end of this time we noted the cellulose acetate coating had very little efficiency, for with the alternate action of dryness and moisture the coating cracked off and the ammonium phosphate was rapidly washed away by the rain. The painted test pieces showed that the paint furnished sufficient protection for the fireproofing solution, especially in the case of the pine planks. With the poplar, more permeable than the pine, it is supposed that water penetrated to a certain extent, and dissolved a part of the fireproofing salts. Asbestos mixed with the solution showed no additional protection.

Summarizing the results, we concluded that planks, especially pine, fireproofed by the application of two coats of ammonium phosphate, and then painted, will retain their properties for about two months when exposed to the weather. We should observe, however, that the application of fireproofing coatings of this kind furnishes at best an uncertain protection, and that its durability varies with atmospheric conditions.

Recent tests show that a sufficiently concentrated solution of sodium silicate, applied with an air brush, also furnishes an efficient protection, and equally well resists the action of water when painted.

FIREPROOFING BY METALLIZATION OF THE SURFACE. Recent processes (see *Genié Civil*, December 21, 1912, p. 154) enable us to metallize the

surfaces of various materials, in particular, wood, by means of a very simple apparatus. The best metals for this are zinc, brass, aluminum, and tin.

We metallized with zinc, aluminum, and tin, test pieces of pine and poplar, also pieces of scenery canvas and heavy paper. Fire tests, similar to those previously described, showed zinc and aluminum to be the best fireproofing materials. Under the action of flame, these metals oxidize, giving a protecting coating; tin, on the other hand, melts to form globules and affords no protection.

The fireproofing value of zinc and aluminum on wood with about 2 grams per square decimeter (0.7 oz. per sq. ft.) (1.5 grams for aluminum and 2.34 grams for zinc) is of the same order as that of the ammonium phosphate. Metallization of fabrics and paper we found to have little or no fireproofing value.

Zinc is the least expensive of these metals, and costs about 10 francs per square meter (1 sq. meter = 1.2 sq. yds.) This price, including the labor cost, is much higher than that of the salt solution. But we feel that, when the cost of this process has been considerably reduced, this method can be advantageously used for the protection of wood which is to be exposed to rain or dampness, especially in view of the fact that with metallization the condition of the protective coating can be readily determined by visual inspection.

Practical Tests.

In order to verify the laboratory results by tests simulating actual theatre conditions, we made tests on three poplar frames, 1.5 cm. (9/16 in.) thick, 1.2 meters (3. ft. 11 in.) wide and 2 meters (6 ft. 7 in.) high. Canvas was stretched on these frames in exactly the same manner as used in theatre sets. The three frames received the following treatment: the first, no treatment; the second was treated with the borax-boric acid solution; on the third the canvas was treated with borax-boric acid solution and the frame with two coats of the ammonium phosphate solution.

The frames were suspended side by side vertically above a fire of excelsior in an explosion pit. The flames rose to a height of about 1 meter (39 in.), lasted several minutes, and lapped the test frames for about half their height. The canvas on frame No. 1 burned freely and was completely consumed in less than one minute. The canvas of frames 2 and 3 was about half carbonized where it had been in contact with the flames from the excelsior; it burned without flame, and carbonization stopped when the excelsior fire had subsided. The wood of the frames was simply carbonized; it did not burn.

After this, in order to test the relative behavior of the treated and untreated wood in a larger fire, we suspended the three frames parallel in the pit, with a distance of 15 to 20 centimeters (6 to 8 in.) between them. Under the frames we built a large fire of excelsior which lasted many minutes. The canvas remaining on frames 2 and 3 was consumed without the production of flame. The frames themselves then burned, the one which had been fireproofed showed considerably more resistance to fire and when ignited burned with less intensity than the others.

These practical tests show that:

1. As already stated, the fireproofing of fabrics by means of a mixture of borax and boric acid has a remarkable efficiency.

2. The wood used in the frames of theatre scenery, when 1.5 centimeter (about 5/8 in.) or more in thickness, has comparatively low inflammability.

3. Surface treatment with ammonium phosphate solution of 250 grams per liter (1 lb. 14 oz. per gal.) reduces their ease of ignition, also the rate of combustion and the size of the flames.

Consequently, the results of the tests completely justify our position as to the necessity of fireproofing canvas, and show the value of fireproofing treatment for thin wood, especially when the surface is rough, but that this treatment may well be dispensed with when the wood is more than 2.5 centimeters (about 1 in.) thick and the surface is planed.

Conclusions.

The foregoing shows that efficient fireproofing is possible for fabrics and thin wood which are so used as to be especially susceptible to fire. This protection can be applied with small expense and without the inconveniences for which fireproofing has been criticized. Consequently fireproofing can be required, with no serious inconvenience, wherever important to protect the public, or especially valuable objects.

In conclusion, we should remark that if this problem has remained unsolved for a long time, as we have shown in this long historical resumé, it has been because of a lack of co-operation between the research organizations, the users, and the enforcing authorities.

There are many problems in connection with the safety of the public and the protection of large establishments against fire which could be speedily solved but which, at the present time, cannot be attacked experimentally because sufficient means are not available. There is an unfortunate tendency in France to follow empirical methods rather than to have recourse to science, especially in connection with fire prevention and fire protection.

In other countries there are laboratories (e. g., Underwriters' Laboratories, Chicago), generally founded through private initiative, which, having means available, work efficiently for the solution of such problems, for those who maintain them.

Our country should become more interested in these questions year by year, and do more in combating fire which takes as its toll so many lives and millions of property.

Exhausted Battery Units.

Their Fire Hazard.

The Edison batteries largely used for railroad signal work contain plates made of finely divided copper oxide, according to a report of the Bureau of Explosives (Member N. F. P. A.) made to the Railway Fire Protection Association. The action of the battery is to reduce this copper oxide to finely divided metallic copper. This material on removal from the battery and when moist and exposed to air again oxidizes, forming copper oxide and producing heat. If a large quantity of these exhausted battery plates are together and sufficiently confined to retain the heat, ignition may occur.

Several fires from this source have been reported to the Bureau. The remedy for these fires is to leave the plates freely exposed to the open air for at least a week before placing in any closed container, or before shipment.

Charles P. Beistle, chemist of the Bureau, who is a member of the N. F. P. A. Committee on Hazardous Chemicals and Explosives, reports to the R. F. P. A. an experiment made with such battery plates.

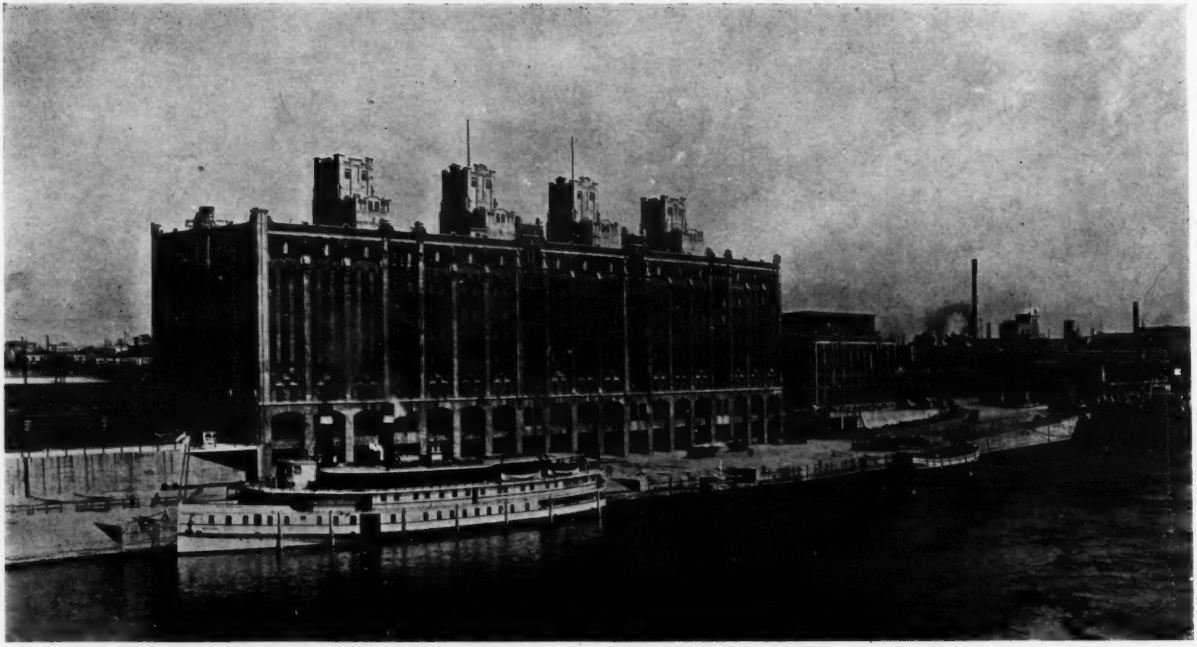
A sample of "spent copper oxide" battery plates was received by Mr. H. A. Hausler, General Storekeeper, Chicago, St. Paul, Minn. & Omaha Railway.

These plates as received were in the form of broken pieces of plate approximately 1.2 inch thick. This material was almost black on the outside and somewhat reddish on the interior. The black was cupric oxide and the reddish material was cuprous oxide or finely divided metallic copper.

This material was broken up in an iron mortar and moistened with water; it was then closely packed in a wooden box 8 inches cube. This box was placed in an incubator oven held at 40° C. Within 48 hours the temperature rose to 47° C., due to the oxidation.

These copper plates as first made consist of black cupric oxide in a finely divided condition. The action of the battery is to reduce this copper oxide, leaving free metallic copper, which is likewise in a finely divided condition. The exhausted plates when first removed from the batteries consist of this finely divided metallic copper, which when exposed to the air and moisture re-oxidizes. When a large amount of this material is together, the amount of heat developed by this condition may be sufficient to cause a dangerous amount of heat.

The manufacturer recommends that these plates on removal from the batteries should be freely exposed to the air for twenty-four hours and that the reoxidation will then be complete. As a matter of precaution, however, Mr. Beistle thinks such period might well be lengthened, and the plates be placed during this period where the development of heat will do no injury to adjacent material.



The new Montreal Cold Storage Warehouse. This building is protected by a system of automatic sprinklers using a non-freezing calcium chloride solution, supplied by four 50,000-gallon gravity tanks in the towers. The power and refrigerating machinery is located in the detached power house at the right of the picture.

A New Calcium Chloride Sprinkler System.

In the Montreal Harbour Commissioners' Cold Storage Warehouse.

By Major R. Percy Sims, Consulting Engineer.
(Member N. F. P. A.)

The new Cold Storage Warehouse of the Harbour Commissioners of Montreal is one of unusual interest, not only on account of its magnitude and its artistic exterior design but on account of the many special and important features which have been introduced into its equipment. Of these special features, the automatic sprinkler and fire alarm systems are among the most interesting.

When this warehouse was in the initial stages of design, the writer was of the opinion that it would be considerably to the advantage of both the owners of the building and the owners of the goods stored therein to install an automatic sprinkler equipment throughout. Although the building itself is of fire resistive construction, it contains goods valued at millions of dollars, which are usually packed in cases and packages of an inflammable nature. Consequently, the Manager of the Sprinkler Department of the Canadian Fire Underwriters' Association was invited to meet the Chief Engineer of the Harbour and the writer, with a view of discussing the matter and ascertaining the requirements so that the building could be so designed to meet all such requirements without subsequent alterations. From the discussion that ensued, it was evident that he was not in favor of the use of automatic sprinklers in very low-temperature properties. The Chief Engineer of the Harbour Commission and the writer were informed that, although the dry-pipe system of automatic sprinklers was approved, the performance was often so unsatisfactory and unreliable that no reduction in the premium rate could be made for sprinklers in properties having a temperature of 10° F., or below.

Realizing the many advantages of the automatic sprinkler when operating as is intended, the writer decided to investigate the sources of its alleged unreliability when installed where subjected to very low temperatures and ascertain if the defects were physical, mechanical or otherwise, and if they could be rectified.

From his investigations, the writer found that there had been many failures of automatic fire sprinklers in cold storage plants, principally due to the freezing of the condensation or moisture in the compressed air used in the dry-pipe system; this taking the form of frost gradually building up on the interior surface of the pipe, especially at the entrance of the pipe into the cold storage rooms. In other cases, the condensation had drained into low spots or pockets and had been frozen solid. The result was that the water supply, when the sprinkler head opened, was seriously retarded in its initial flow to the head and, in some cases, the

flow was entirely prevented. In a properly designed dry-pipe system of automatic sprinklers, this condensation trouble can be eliminated or considerably reduced by drying the air previous to its introduction into the system, and also making sure that such air is, at least, as low in temperature as that of the cold storage rooms. Another trouble which is sometimes experienced with the dry-pipe system of automatic sprinklers is the tripping of the dry-pipe valve, due to the loss of pressure in the system other than by the normal operation of a sprinkler head; whether this tripping is caused by undue leakage, failure of compressor or any other cause, the result is that the system is flooded with water, with serious possibilities of damage where there are very low temperatures. In a building such as the Cold Storage Warehouse at Montreal, each floor is divided into several rooms, each opening on to a distributing corridor, and on some of these floors each room is maintained at a temperature ranging from Zero F. to 10° F. In the event of a fire occurring in one of the rooms and it being successfully extinguished by the automatic fire sprinklers, the sprinkler system in the adjacent rooms would be flooded with water, and the pipes in those rooms would, in all probability, be frozen up solid before discovery. It would be reasonable to expect that a large proportion of these pipes would be split, in which case the room or rooms would have to be emptied of their contents and the sprinkler equipment repaired or renewed, during which time that part of the building would be without automatic fire protection, to say nothing of the cost and inconvenience to the owners of the building.

No one questions the advantages of the usual water-flooded system of automatic sprinklers over that known as the dry-pipe system, which explains why the latter is used only where the former is impracticable. The wet system is not subject to the delay incidental to the distance of travel of the water from the dry-pipe valve to the opened heads, which travel is often retarded in cold storage plants by the frost or ice in the pipes, as previously described; and also by having to expel a considerable amount of air in its passage to the heads. It, therefore, seemed that a wet system in the new Cold Storage Warehouse at Montreal would be more satisfactory than a dry-pipe system, if the extinguishing liquid in the system were non-congealing at the lowest operating temperatures, and which would not adversely affect the efficiency of the system. As the refrigeration of the warehouse is by the circulation of a solution of calcium chloride through coils of pipe suspended from the ceilings of the rooms, it was considered that a similar solution, of the same specific gravity, in the automatic sprinkler system should prove satisfactory.

Objections to the Calcium Chloride Sprinkler System.

As there appeared to be a universal condemnation of any use of a calcium chloride solution in connection with automatic sprinklers on the part of insurance and automatic sprinkler experts, it was considered that some careful investigations into the reasons of such unsatisfactory service might show that some, if not all, of the defects could be remedied. Almost without exception, it was found that the failure was not due to the use of the solution of calcium chloride as much as the lack of ordinary intelligence in its use. For instance, numerous cases were found where the

system was filled with a solution during the winter months and with water during the remaining months; such a practice is sure to cause rapid corrosion on the interior surface of the pipes, and the blame is put on to the solution. It is remarkable how few people are aware that so long as a pipe or vessel is filled with a solution of calcium chloride of the proper specific gravity and free from air, so long will the interior surface of such pipe or vessel remain free from corrosion; but if the solution is changed periodically for water or air, rapid corrosion takes place. An instance of failure often quoted was that of the Semet-Solvay Company; it was pointed out that, as manufacturers of calcium chloride, it was to the business interests of the Company that this material should be used in automatic sprinkler systems and that everything that could possibly be done to ensure the success of their own installation would be done, yet it failed through excessive corrosion. From the investigations conducted by the writer in this particular case, it was found that the corrosion which condemned the system was on the outside of the pipes, due to the strong chemical fumes of the plant, and that the interior surfaces of the pipes were in as perfect a condition as when erected; yet calcium chloride got the blame. Another frequent cause of failure has been the lack of intelligence in the preparation of the solution required; the owner of a building would require a part of his sprinkler system, such as an elevator shaft or some other unheated portion, to be filled with a non-freezing solution during the winter months. He would send to the drug store for a few pounds of chloride of calcium or even chloride of sodium, put it into a few hundred gallons of water, fill up his sprinkler system and then forget all about it, quite satisfied that he has done the right thing. The first really cold day puts his sprinkler system out of commission, and the solution is blamed; as a matter of fact, it is the solution which is the cause of the failure, but if it had been properly prepared there would have been no failure. The owner would never admit that he did not prepare the solution to a specific gravity to prevent its congealing under the lowest temperature to which it might be subjected.

Another frequent cause of trouble with calcium chloride sprinkler systems has been the use of dissimilar metals adjacent or touching each other and in contact with the solution; this often causes a slight electrolitic action, which can be eliminated by careful thought in the design and construction of the equipment, and the use of a neutralizing agent.

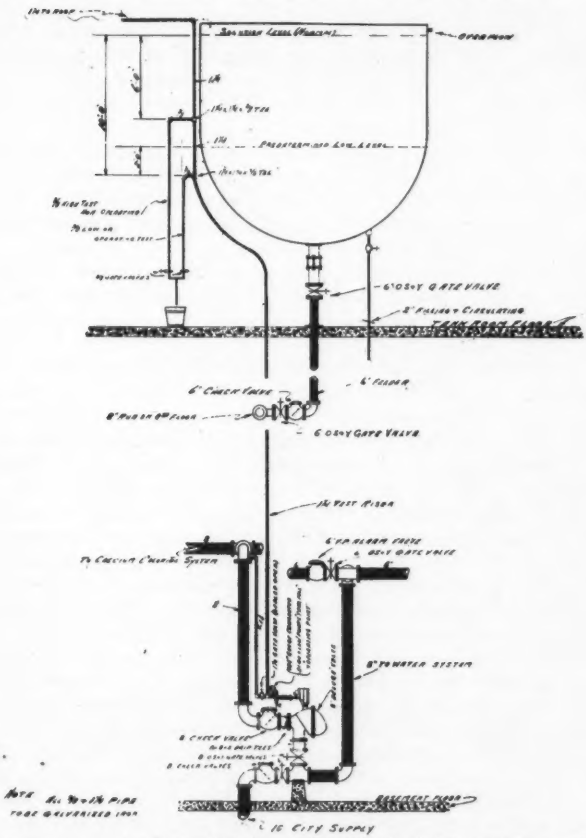
Numerous other cases could be given where failures in calcium chloride flooded systems of automatic fire sprinklers had resulted from causes other than the solution, and yet in almost every case the use of such a solution is blamed for the trouble.

The Secondary Supply.

The main difficulty which loomed up at first was the problem of providing surely, automatically, and promptly, a plentiful supply of water from the city mains when the primary supply, consisting of the solution of calcium chloride had been exhausted. It was decided that the best way to accomplish this would be to have the primary supply, or calcium chloride solution, in storage tanks situated above the roof, and when the level of the solution in these tanks reached a predetermined low level, an

automatic valve would be operated to supply city water to the system. There were three ways in which the connection between the overhead tanks and the automatic valve could be made—electrically, mechanically and hydraulically. Due to the long distances between the overhead tanks and the automatic valve, the idea of mechanical connection was soon abandoned. To make the connection electrically, it would have necessitated a float in each tank to operate an electric switch which would transmit electric current to a solenoid or motor attached to the valve and so cause it to trip. The possibility of disruption to the electric current resulted in this method also being abandoned and it was eventually decided to make the connection hydraulically. By this method, the automatic valve is tripped by the difference in head pressure between the normal height of solution in the overhead tanks and the predetermined low level, similar to the action of the predetermined drop in pressure in the air of a dry-pipe system. However, in the hydraulic arrangement, due to the distance between the normal and the low levels in the tanks being only a few feet, the difference in head pressure is very slight and necessitates the use of a very sensitive and positive valve.

After many experiments, it was found that the ordinary approved differential-type dry-pipe valve was not sufficiently sensitive for this duty, and it was therefore decided to adopt the "Deluge" valve. This is a new type of differential valve in which, when closed, the back of the larger clapper is open to the full pressure of the city main and thus holds down the smaller clapper on to its seat; the outlet from the valve leading into the sprinkler system being between the two clappers. Immediately above the valve proper is an iron box containing the release or tripping mechanism for operating a quick-opening valve connected to the upper side of the larger clapper and thus destroying the pressure thereon, enabling the smaller clapper to rise from its seat and permit the water from the city main to flow into the sprinkler system. This tripping mechanism is actuated by a spindle attached to a diaphragm which is directly connected by a small pipe to the main riser of the sprinkler system. The diaphragm is subject to adjustment by means of a heavy tension spring, in the event of any deliberate change in the head pressure of the sprinkler system, but at the present time it has been set to operate on a maximum head of 133 feet of calcium chloride solution of a specific gravity of 1.261, and will remain inactive on heads greater than this. In tests made of this valve, the greatest variation in operating head-pressure was one-half pound per square inch, as indicated by the pressure gauge, which is approximately equivalent to one foot in head of the calcium chloride solution at a specific gravity of 1.261. Between the base of the calcium riser and the Deluge valve, there is a horizontal check valve for preventing any of the solution reaching any part of the Deluge valve. These two valves are separated by a short distance piece which, under normal conditions, is open to the atmosphere by means of a ball drip. In the event of any leakage past the Deluge valve or the check valve, it would be immediately detected by the operation of the ball drip and it would also be very easy to determine which valve was leaking by the taste; up to the time of writing, with over six months operation of the installation, there has been no drip to record. In addition to the small



Arrangement of the Calcium Chloride Sprinkler Tanks and City Water Connections.

connection between the calcium chloride riser and the diaphragm, there is a small test riser direct to the diaphragm from the overhead tanks which enables the Deluge valve to be tested without changing the levels in the tanks. A pressure gauge, attached to the pipe leading into the diaphragm, indicates the pressure of the solution; another pressure gauge is connected to the atmospheric chamber of the ball drip and should, under normal conditions, indicate zero pressure; a third pressure gauge is connected to the water supply side of the Deluge valve.

From the illustration of the set-up of the Deluge Valve Arrangement in the Cold Storage Warehouse in Montreal, it will be seen that there are two risers—one is to the calcium chloride flooded system of sprinklers and the other is to the water flooded system. In planning the whole installation, it was decided to equip all the parts of the warehouse which were heated, such as corridors, offices and unrefrigerated spaces, with the

ordinary water flooded system of automatic sprinklers, and all refrigerated spaces and such spaces as might be subject to outside atmospheric conditions with the calcium chloride flooded system. At the present time, there are two floors in the building which have been specially designed for future cold storage purposes, but which have not yet been insulated or equipped with refrigerating apparatus. In the meantime, these two floors are heated and used for ordinary storage purposes and are equipped with the water flooded system of sprinklers, but so arranged that they can be connected to the calcium flooded system with the least possible interruption to the sprinkler installation as a whole.

In order to ensure the reliability of the continuity of the proper connection between the main water supply and the calcium chloride flooded system of sprinklers, it was decided to divide the water supply before it entered the building into two 10-inch branches instead of one 12-inch main and, furthermore, to feed this 12-inch main from two separate directions of the city supply. In addition, the Deluge valve arrangements are duplicated, one being located in the east end of the basement of the building and one in the west end, but which are interconnected by a header which forms part of the calcium ring main, hereinafter described. In the event, therefore, of one of the 10-inch water supply pipes being damaged or one of the Deluge valve arrangements being out of commission, the continuity of the service is assured.

From the calcium header in the basement which connects the two Deluge valve arrangements, there are two 8-inch main risers passing through the building up to the top floor, where they are again interconnected by a header and forming a complete 8-inch ring main, to which the outlets of the four overhead storage tanks are directly connected. From the calcium header in the basement are three 6-inch distributing risers for connection to the sprinkler lines of the calcium chloride system, which divide it into three main sections controlling the east, centre and west portions of the building, respectively. All these risers, as they pass through the various floors, are enclosed in small rooms which would be used as dry-pipe valve rooms if it were decided at some future time to change the calcium chloride flooded system over to the dry-pipe system. This was merely a precaution, due to the novelty of the system adopted, and there does not now seem to be any reasonably probable chance of the change being made.

The four overhead storage tanks are situated in four concrete towers above the level of the roof of the warehouse, and each contains, normally, 15,000 imperial gallons of the calcium chloride solution of a specific gravity of 1.261, which has a freezing temperature of about 40° below zero F. It was found, from many experiments conducted by the writer, that this solution has a greater extinguishing effect than water, and it is therefore reasonably considered that this quantity of solution will be more than necessary to extinguish any ordinary fire in a building of this character.

It was to be expected that, being such a departure from the usual accepted standards for this class of property and in a building of such size, the calcium chloride flooded sprinkler system would receive its full share of criticism; at times it seemed so overwhelming that the proposal

would have to be abandoned. The only ray of encouragement was the absurdity of some of the criticisms, proving that they were made without proper knowledge or thought of the subject, or governed by prejudice. Corrosion and electrolysis were repeatedly quoted, and these two possible sources of trouble have been fully dealt with in an earlier part of this article. One great objection raised by many was the use of an automatic valve, which they were sure would never function just when it was needed, yet they seemed to forget that in the system they favored an automatic valve has to be used, called the dry-pipe valve; the main difference being that in the dry-pipe system the automatic valve is expected to function every time a fire occurs, whereas the Deluge valve in the calcium chloride flooded system may not be required to function once in one hundred times, thus reducing to a minimum the very objection which was raised against it. Furthermore, in a building of the size of the Cold Storage Warehouse at Montreal, it would have required fifteen dry-pipe valves if the dry-pipe system had been installed, whereas with the present system there are only two Deluge valves. However, while there was much destructive criticism, yet there was much more constructive criticism, which was keenly welcomed and which proved to be of great assistance to the writer in bringing the system to such an efficient and reliable condition as it now is. He is particularly grateful for such technical help from Mr. M. H. Matthes, Chief Engineer of the Firemen's Mutual Insurance Company, Mr. E. A. Lowe and Mr. T. H. Higginson of the "Automatic" Sprinkler Company.

As previously stated, part of the warehouse is protected by the ordinary water-flooded system. The area thus covered consists of the offices, the floors which are not at present refrigerated but are heated, and the distributing corridors of the refrigerated floors. The two 10-inch water supply mains entering the building at the basement are interconnected by a main header on the ceiling of the basement, from which rise the three six-inch main water risers. There are no special features in connection with this water system; it is complete with hose connections, steamer connections, alarm valves, etc.

The Automatic Fire Alarm System.

An exceedingly interesting feature of this installation is the automatic fire alarm system which, combined with the automatic sprinkler system already described, results in the Cold Storage Warehouse in Montreal being one of the best fire-protected buildings in the world. Owing to the great range of temperature between that of the cold storage rooms and that required to operate the sprinkler heads, thus causing undue delay in such operation, it was realized that a more sensitive detection system was needed than that provided by the ordinary sprinkler head. The writer was assisted in arriving at a decision in connection with such a detection system by the very successful results obtained by the Canadian Fire Underwriters' Association in a series of tests, extending over a period of a year, of an automatic apparatus in one of the meat freezers of the William Davies Packing Plant in Montreal. This apparatus consists of two devices—a detector and a release—the former automatically operating the latter on the "rate of rise" principle, with compensating features

which provide the same speed of action in low temperatures as in high temperatures.

In the case of the Cold Storage Warehouse, each freezer and cold storage room is equipped with two to four of these automatic detectors attached to the ceiling, according to the size of the room, there being 36 such rooms opening on to four distributing corridors. The releases on each floor are attached to the wall of the corridor, each one adjacent to the entrance into the room which it controls. Each release is directly connected to its respective detectors by approved air tubing in conduit; it is enclosed in a sheet-iron box and equipped with the necessary circuit-closing attachment and, on the top of the box, a red lamp enclosed in a wire-guarded, weatherproof globe. Each of these thirty-six Release Stations is connected to the common system of main wiring which leads from the source of electric energy in the power house, and, through the medium of high-resistance relay in shunt, is kept under constant test by trouble relay and bell.

Each of the detectors of this automatic alarm system has been set to operate at a *rate* of rise of 15° in temperature of the surrounding atmosphere, per minute. As soon as this rate of rise occurs, the Release Station affected operates its red light, thus indicating the room in which the abnormal rise has taken place; it operates the local alarm bell, which indicates the floor affected, and it also simultaneously operates the general alarm bells in the office of the superintendent of the warehouse and in the power house. The great importance is the almost instantaneous action of the system, even before the general temperature of the room has risen one degree. By such prompt and positive action of the system, the warehouse staff or local fire-fighting crew should be able to reach the floor and enter the room affected in a minimum of time and control the fire with the aid of hand extinguishers or the hose connections in the distributing corridor before the automatic sprinkler heads are even expected to operate, thus minimizing the damage to the building and its contents by fire and liquid. This, at first thought, may seem an exaggerated statement, but the fact remains that though an automatic fire sprinkler head may be set to operate at a predetermined limit of rise in temperature of, say, 165° F., yet the surrounding atmosphere often reaches 50 per cent. higher than that limit before the head operates, and in a cold storage room having a normal temperature of zero F. a very considerable time would elapse and much fire damage would be done before the sprinkler head opened, assuming the average rate of rise of temperature at 20° per minute.

In addition to the special automatic alarm system just described, all the fire doors at the stairs leading from one floor to another and at all the elevators in the Cold Storage Warehouse are each closed automatically by the operation of a Lowe Release, in the event of the surrounding temperature rising at a rate of 15° per minute, or more.

Calcium vs. Dry-Pipe System; Relative Cost and Insurance.

At the time when the building was ready to receive its fire protection equipment, alternative plans and specifications were prepared covering the installation of a complete standard dry-pipe system and the combined calcium chloride and water systems as described in this article, and tenders

were invited from the principal sprinkler contractors on the alternative systems. Further, the larger insurance organizations were invited to submit alternative premium proposals on the insurance of the building, its equipment and its contents, in accordance with the three following suggestions:—

(a) If the Warehouse were not equipped with any automatic sprinkler system.

(b) If it were equipped throughout with a standard dry-pipe system of automatic sprinklers.

(c) If the installation consisted of the combined calcium chloride and wet systems.

There were three main reasons for preparing alternative plans and specifications and inviting tenders for the installing of the two alternative systems, and also for the invitations covering premium proposals under the three alternative suggestions. First, it was considered advisable to have the tenders for installing both systems available in the event of the underwriting organizations not approving the combined calcium chloride and water flooded systems; secondly, it was desirable to ascertain the relative cost of the two alternative systems; and, thirdly, the relative value of the protection offered by each of the three alternative suggestions would be indicated by the respective premium proposals offered.

Dealing first with the matter of insurance, replies were received from the insurance companies on all three specifications and after careful consideration of the whole matter the Harbour Commission decided to place the insurance with the Associated Factory Fire Mutual Insurance Companies, who had expressed confidence in the efficiency of the proposed combined calcium and water flooded systems of automatic sprinklers for the Cold Storage Warehouse.

So far as the tenders for the installing of the two alternative systems were concerned, it was found that the average amount for the dry-pipe system was slightly over 12 per cent higher than the average tender amount for the combined calcium and water flooded systems. The contract for the whole of the work covering the automatic fire sprinkler system and the alarm system was placed with the "Automatic" Sprinkler Company of Canada, Limited.

Of course, the period of the operation of this special fire protection equipment is yet short and there have been, fortunately, no fires in the building to test out the efficiency of the system under such conditions, but everything that engineering science could suggest has been introduced into the system in order to ensure it being as reliable and as perfect as possible.

Taking into consideration the magnitude of the building and the novelty of the proposed installation, the action of the Harbour Commissioners of Montreal was a bold one, but the writer is confident that their action was and will be fully justified. It is an undertaking which will be watched with considerable interest by all concerned with fire protection for buildings of this character.

Photographs by Courtesy of Fire and Water Engineering.

Two interesting views of a fire on an oil covered pond at Everett, Mass., on November 26, 1922. Water only served to spread the fire so foam was run through the hose lines. The upper photograph shows firemen with foam lines and the lower shows a dory which was swamped when the fire department attempted to handle two water lines from it. The foam smothered the fire and prevented serious damage to adjoining property.

The Importance of Testing Extinguishers.*

L. F. Wilcox.
(Member N. F. P. A.)

It has been remarked that the words of the old song, "You never find two alike at any one time and you never find one alike twice," may be applied to Fire Inspectors as well as to the fair sex. Certain it is that in few callings is there greater chance for each individual to develop along his own particular lines.

Some inspectors are fiends on electric defects, even going so far as to take out every plug fuse in order to see whether or not a coin has been inserted. Whether this is primarily in order to increase their bank account or not we have never learned, but in all our travels we have found few such "bugs" on fire extinguishers as ourselves. The majority of inspectors seem to feel that if an extinguisher is tagged correctly, all is well, but in the last few years we have found the following defects in the soda and acid type:

1. Sodium bicarbonate solution frozen; in some cases hard enough to burst the tank.
2. Acid bottle frozen.
3. Nozzle plugged.
4. Cap screwed on so insecurely that on discharging, it blew off, barely missing the operator.
5. Tank soldered. In many cases this would have proved dangerous to operate.
6. Acid bottle broken.
7. Cage for acid bottle broken, dropping bottle into solution.
8. Stopple for acid bottle missing.
9. Gasket missing.
10. Iron ball, intended to break bottle when tank was upset, stuck in unmixed bicarbonate of soda at bottom of tank.
11. Empty. The intention was to keep it this way, and charge it after the fire was discovered.
12. Not recharged after using.
13. Charges put into extinguisher unopened, and in some cases, water added.
14. Pasteboard collar which was put around neck of bottle when shipping had not been removed, thus making it impossible for sufficient acid, if any, to mix with the soda solution.
15. Hose broken through kinking.
16. Nozzle cut off.
17. Hidden in all sorts of out of the way places, particularly in closets and behind curtains.
18. Taken home by employees to use as a still.

While we have met with fewer of the calcium chloride type, several

* From News Letter No. 9 of the Railway Fire Protection Association.

of the above defects have been found as well as the following which are peculiar to the type:

1. Plunger frozen so that it could not be moved with a hammer.
2. Gas cartridge empty.
3. Gasket so thick that plunger could not pierce lead seal of gas cartridge.

As to the one-quart carbon tetrachloride type, these have been found in all sorts of conditions and places, some of the more frequent defects being the following:

1. Nozzle gummed.
2. Empty or nearly so.
3. Rod stuck.
4. Full of water.

Fire Fighting in Shanghai.

The annual report for 1921 of Chief Officer M. W. Pett (Member N. F. P. A.) of the Shanghai Fire Brigade gives an interesting picture of the conditions with regard to fire protection and fire fighting in China. The Shanghai Brigade is composed of a foreign staff of fourteen and a Chinese staff of three hundred and twelve. There are five fire stations equipped with motor apparatus. There is no fire alarm telegraph system, the brigade being dependent on telephones and watch towers for receiving alarms. An inadequate water supply and lack of sufficient hydrants prevent the most effective work. The conditions met with can best be illustrated by the description of the North Soochow Road conflagration of March 11, 1921. This fire caused a loss of six million taels,* exceeding the total loss of the past decade by over one million taels and being 22 times the entire fire loss in Shanghai for 1920.

The fire, presumably of incendiary origin, started in a large group of godowns (warehouses). From the fire point of view they had been previously recognized as hazardous by the department. This group was divided into four blocks with an 18-foot passageway intervening running east and west and a 12-foot passageway north and south. These godowns were two storied, brick walls, with galvanized iron roofs, wood lined, used for public storage of general merchandise, mainly silk and cocoons. The majority of the contents were under lien to native banks.

The first intimation of the fire was given by the watch towers over a mile distant. Machines from Hongkew and Sinza stations arrived simultaneously, but the heavier machines from the latter division were delayed somewhat, as North Thibet Road bridge was up for repair.

The fire had obtained great headway before aid arrived, on account of the construction and contents of these buildings. From the outset the brigade were in difficulties, not only on account of the extraordinary way in which the fire started and burned, but owing to lack of water. Although the area was approximately 350 feet by 300 feet, there were only four hydrants immediately available and these were the old 2½ inch pattern.

* A tael is approximately 73 cents at normal exchange.

Pumps were got to work from the creek, but owing to low tide, the mud impaired their efficiency and they were finally removed, especially as they were in danger from collapsing walls.

The brigade took up every vantage position possible and made a determined fight against inconceivable odds. The east wall of a godown collapsed in an incredibly short time. Undoubtedly this godown was excessively overloaded, like the others, and with its collapse North Thibet Road was blocked and a rice mill seriously endangered, immediate attention having to be paid to save it.

Apart from the godowns involved, there was also a very large block of Chinese shops and dwellings which were at times swept by flame, and the hydrant on the north side had to be exclusively used to stop the conflagration from spreading here.

The three divisions of the brigade in attendance put up a strenuous fight. Time after time men had to give way gradually and reluctantly, but not before being absolutely compelled to do so, the hose streams being extremely feeble and ineffective against such terrific heat. The staircases of the godowns were of little use, being packed with flammable merchandise, such as silk cocoons. Openings had to be made through the roofs, as safe retreats, when the staircases became impassable. Again the wood lined galvanized iron roof acted only as a spreader of fire. Although men got on several of the roofs, it was soon impossible for them to remain owing to the heat attracted to the galvanized iron. The so-called division walls were absolutely useless, as there were openings around the joists and beams which allowed the fire through; they quickly collapsed with the excessive overloading, and were extremely dangerous to work behind or against.

At the end of two hours the situation was controlled. It is interesting to note that the fire did damage at the rate of approximately 55,000 taels per minute, so rapid was the rate at which it burned.

To summarize, the most striking points about this fire were the totally inadequate number of hydrants, lack of water and water pressure, overloading and congestion in the godowns, storage of flammable goods, blocking of staircases, useless fire walls, wood lined galvanized iron roofs, barred windows, treble padlocked doors, the man with the keys absent, and the general congestion of the whole block.

Chief Officer Pett makes the following interesting observations concerning the general situation in Shanghai:

"It is somewhat surprising that such little regard is paid to the element of fire, one of the most dangerous enemies of mankind; an enemy which is in the ascendant, and which causes untold damage; the attempts to deal with which are on the whole comparatively puny. People are most conservative where the bugbear of fire is concerned. It is spoken of as a most unlikely occurrence, nothing to worry about, and even when a conflagration does happen, it is a passing mystery, quickly forgotten, and very rarely has a moral effect.

"One hears a good deal today of disarmament to reduce heavy national expenditure. It is to be regretted that more is not heard of an organized attempt for the disarmament of fire, with its attendant loss of life and appalling waste of property, which instead of being lessened grows with alarming rapidity.

"It is extraordinary that the loss of life by fire in Shanghai is not exceedingly heavy, considering the apathy by both owners and tenants alike to this very real danger.

"Any advice, or measures of fire protection taken or advised, is generally looked upon as unnecessary, or entailing irksome conditions. The old saying, 'Prevention is better than cure,' is certainly not appreciated in Shanghai. In this respect it must be remembered that more precautions are needed here than elsewhere, owing to the light construction of the majority of houses, excessive overcrowding, and overloading. In regard to overcrowding, the increased rents and high cost of living made this a very acute question. It is quite common to find the ground floor of a Chinese house used for industrial purposes, and the top floor occupied by as many as 15 to 20 persons, only one light wooden staircase leading into the shop, and no back exit."

A typical loss of life fire reported is as follows:

CHEKIANG ROAD. Serious loss of life occurred at this fire; three men, four women, and one boy losing their lives. The premises were a colored fire and theatrical fitting shop. A man was rolling a highly inflammable powder in a trough, when the roller came in contact with a foreign substance, causing a spark, which was followed by an explosion. The shop was full of bamboo and paper figures, etc., and by the time the division arrived the building was a furnace. These eight people were upstairs, and there was only one flimsy staircase leading into the shop, and no back exit, but strange to say they had never moved from their positions or made any attempt to escape.

That Chief Officer Pett is thoroughly conversant with the situation as it applies, not only to Shanghai but in this country, may be seen from his remarks on fire prevention. He says: "The main hope of the future lies in popularizing scientific knowledge and doing everything conceivable to encourage fire prevention, as it will be only by such means that the fire waste will be held or reduced."

"These remarks apply to Shanghai in an even stronger degree, as apart from the disregard of preventive measures, the carelessness and folly displayed in connection with fire are little less than suicidal.

"The writer is well aware from experience that it is an extremely despondent task to be one of the new school in methods to cope with this problem, especially as there is such a rooted idea that in some occult way insurance is actual protection. The only time the majority of people are worried about fire is when the policy is expiring, forgetful that they and not the insurance company are paying for that policy and that it is not the company but themselves, i.e. the insured, that actually pay for the fire losses. Any saving that can be made in the way of such losses is beneficial to everyone."

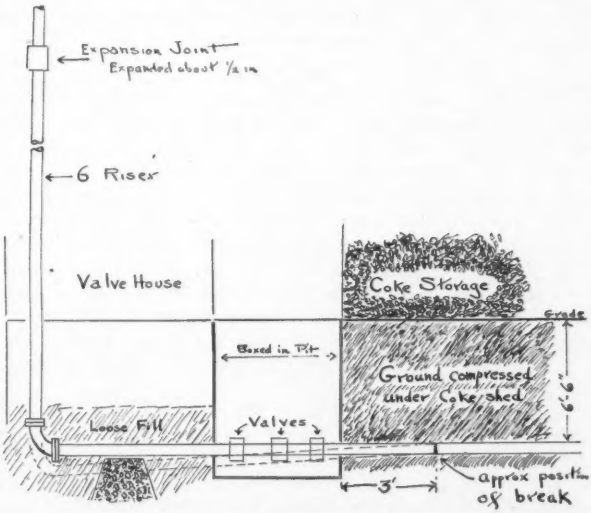
Freaks of Fire and Frost.

Canadian Fire Underwriters' Association.
(Member N. F. P. A.)

This article describes the impairment of two sprinkler equipments, under unusual conditions, by the contrasting elements fire and frost.

By Fire.

A spark from a fire under a varnish kettle in an oilcloth factory quickly communicated to soot in the 75-ft. brick stack. A forty-mile gale created sufficient draft to carry blazing soot from the stack, setting several small and easily extinguished fires in the fences which surrounded the property. It also blew flaming gas directly against and about midway of the height of the frostproof boxing of a sprinkler tank supported on a 90-ft. steel tower and situated 100 feet distant from the varnish boiling house.



Sketch of riser and feed line showing the location of the break.

The boxing immediately caught fire and through the agency of the strong wind burned so quickly that it had to be entirely removed. A stream of water from a motor pumper of the public fire department prevented damage to the wooden tank.

The overflow pipe inside the frostproof casing was warped out of shape from the heat of the burning wood, no means of expansion having

been provided. The swing joint of the heater pipe prevented damage to it.

During the fire a very bad leak developed in the yard main beyond the controlling valve of the tank supply. On excavation, a split about 12 inches long was found in the pipe approximately ten feet beyond the tank valve. The main was covered by 6 ft. 6 in. of earth at this point. In the opinion of the chief engineer of the plant, this leak was due to the failure of the expansion joint in the tank drop to traverse more than half an inch and the fact that this pipe at its base was in loosely filled earth and then passed through a wooden valve pit before entering solid ground, which at this point was compressed by a heavy load of coke. It is held that with the poor functioning of the expansion joint, the tank drop was forced down in the loose soil at its base, causing the pipe to split between this point and where it was held in the firm ground. Contributory, if not decisive, factors may have been the presence of the motor pumper at a city hydrant close to the tank and the heavy load of coke directly over the main; or a combination of these.

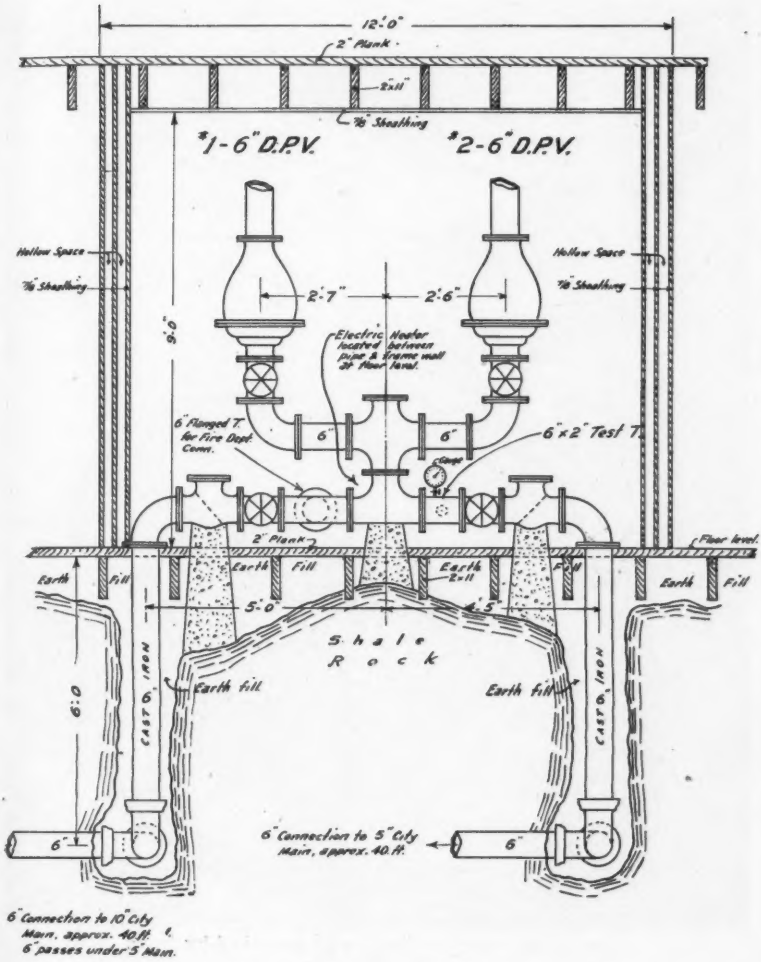
Owing to the location of the break, the most serious result was the impairment for thirty-six hours of approximately thirty-five per cent of the automatic sprinkler protection of a very large plant, in spite of the fact that there were still left in service eight connections from three independent city mains and a fire pump drafting from a private reservoir. This illustrates the need for rearranging yard mains and providing additional sectional control with the growth of a plant. (S-33185.)

By Frost.

The property consisted of a four-story warehouse of light frame construction, without basement. City water was the only supply to the sprinkler equipment, with connections from two independent mains in the street carried underground forty feet and with over six feet of cover, through excavation in shale rock to a frame valve house built to standard specifications and supported on a wooden floor. This enclosure housed all of the controlling apparatus for the sprinkler system. All of the back fill on the property was of soft loam secured specially for the purpose, was said to have been well tamped and to have extended to the under side of the floor at the valve enclosure. An electric heater (18 amperes, 3 heats), taking current from the city electric system, was located at the floor of the valve enclosure six inches from the tee as shown in the sketch.

The equipment was installed in the summer, and on February 6 of the following winter it was found out of service by an inspector of this Association, due to the fracture of the check valve in each city connection. The break was said to have occurred the previous day. The check valves met standard specifications.

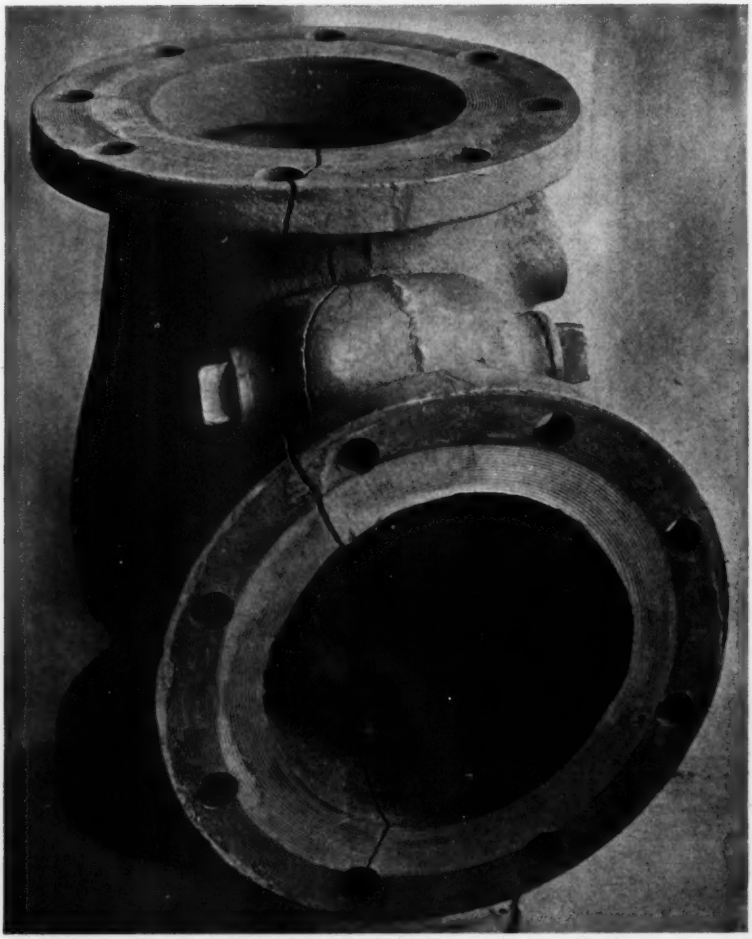
One theory advanced for the accident was water hammer, the city supply being direct pumping with an increase of about 20 lbs. for fire pressure. Inquiry developed that the fire pressure was raised about the time of the break, but examination of the waterworks charts indicated a very gradual increase and the pumping station is over a mile from the property. There were no hydraulic elevators or large users of water in the vicinity, neither had the waterworks authorities carried out any operations in the vicinity of the property for a week previous to the



Sketch of frame valve house enclosing the controlling apparatus to the sprinkler system.

break. There are several other sprinklered properties in the vicinity which did not suffer.

There was no interruption to the electric service supplying power to the property for at least two weeks prior to the accident. It was also ascertained that no difficulty was experienced during installation in bolting up the various parts of the header, so there was no undue strain.



One of the standard check valves cracked by frost.

The weather the last week in January had ranged from ten degrees below zero to eight degrees above, and had moderated to from ten to forty-two degrees above during the first week in February.

After careful inquiry and obtaining the views of the laboratory experts at both Boston and Chicago, as well as the opinion of others, and also from the fact that during the investigation a draft was found under the floor directly at the header, undoubtedly due to the settlement of the earth fill, and that the heater was found not set to operate at full capacity on a fairly cold day, the accident was attributed solely to frost. A peculiar feature was that no other part of the apparatus was dam-

aged. The pressure gauge situated close to one of the check valves was found to register ten pounds high but may have been that way anyhow. It seems remarkable that the two check valves could burst from frost without any other part of the apparatus suffering from the same cause. This may be accounted for by the conductivity of the concrete piers which directly supported the check valves, these piers resting on the shale rock; the presence of the electric heater preventing damage at the central pier. The sprinkler equipment was entirely out of service for three days pending the receipt of new check valves and the attendant repairs. How long it had been seriously impaired by frost is not known.

An Automatic Electric Sub-station Fire.

By F. R. Bradford,
Underwriters Bureau of New England.
(Member N. F. P. A.)

Following is an account of a serious fire in a sub-station which had been converted to automatic control. The fire is a timely illustration of the consequences of imposing partial automatic control on equipment originally installed and arranged for manual control.

Progress in electrical engineering has in recent years resulted in the development of apparatus which allows elaborate equipments of motors, generators, and switching devices, incident to the transmission and distribution of electric power, to operate automatically or by distant control. This development has brought into existence the so-called "automatic sub-stations." Such stations may contain costly equipment and be vital components of important public utilities. Like the attended, non-automatic sub-stations, they may be in localities remote from public protection.

Hand and hand with the development of the automatic devices for the control of the electrical equipment to such a degree that improper operation or serious breakdown is unlikely, there has been such a development of the type of construction and the arrangement of the building and equipment, that the chances of extensive damage to a modern automatic sub-station by fire are greatly reduced.

The obvious economies of automatic operation, however, present a great temptation to owners of power properties to install such control in plants neither built nor arranged for safety under such conditions. The mere provision of the automatic control without certain other protective devices necessary for safety, is another error into which ignorance or the thought of economy may lead the owner. The disasters which may occur in improperly built and equipped "automatic" sub-stations may produce an opinion in regard to the properties of this general class which is not deserved by the thoroughly modern station.

The plant in which this fire occurred was an automatic sub-station which furnished current for street railway use. The sub-station equipment was housed in one end of an old steam electric generating station

of brick construction with joist and timber floor and joist roof. The floor under the switchboard was raised about eighteen inches above the main floor level and the riser tightly sheathed. A small wood-sheathed office was located at one end of the platform about two feet from the end of the switchboard.

The sub-station equipment consisted of a 300 K.W. synchronous motor and D.C. generator set with exciter on the shaft extension, 22,000/2200 volt oil cooled transformers, aluminum electrolytic lightning arresters, high tension oil circuit breaker and a slate on pipe frame switchboard. The steam electric generating equipment is in position but had not been used for a number of years. It consists of a generator located near the end of the motor generator shaft, belted to a reciprocating steam engine. The motor generator set could also be driven through a clutch and belt connection by the engine. Boilers are in a cut off section at opposite end of building from the sub-station equipment.

Power is generated at a station about twenty miles distant and is cut off at the power station at midnight and supplied to the line at about five A. M.

Formerly the sub-station was operated under the supervision of an attendant; but, for reasons of economy, automatic control equipment has been installed and the station has been operated for some time without attendance except for a daily visit by the operator of another station to charge arresters and make a general inspection. The old manual controls, with minor changes, were left in place on the switchboard and new panels added at each end for the relays, breakers and other devices for automatic operation in conjunction with the old equipment. The automatic equipment did not furnish the complete protection usually found in stations which are intended to operate without supervision. Provision was made to start and stop the machine between certain load limits, to limit the speed of the motor, and to shut down the station under certain A.C. supply conditions, but apparently little if any consideration was given to protection against possible faults in the station equipment itself.

At about 5.30 in the morning, shortly after the usual time for applying the power, a neighbor saw a brilliant light from the windows of the station and as soon as possible telephoned to the fire department, which arrived some twenty minutes later. They found that the fire involved a large part of the switchboard and motor, and the roof and floor was burning fiercely. A message was sent to the power house to cut off the power. When this had been done hose streams were used and the blaze was quickly extinguished.

About twenty feet of the roof for the full width of the building was deeply charred but did not fall, the upper part of the office sheathing and the window frames near the switchboard were destroyed and the joist and timbers under a large part of the switchboard platform were so badly burned that they collapsed, letting down one end of the board somewhat. Practically all of the electrical control equipment which was in use on the board was destroyed as were the windings of the synchronous motor. The rest of the electrical equipment was more or less soaked with water. The cables and leads between the various units were either destroyed or baked enough to render them unsafe for use. The oil switch, transformers and lightning arresters were apparently undamaged.

The cause of the fire can not be positively stated as the fire had been in progress for a considerable time before anyone could enter the building. However, a possible and quite probable cause, as described below, is strongly supported by certain prominent features appearing after the fire. The motor field rheostat grids were suspended by lag screws to the underedge of the switchboard platform joists. It appears that these screws heated up enough to char the wood and pull out without actually igniting the joists about them except in one place where the joist was apparently ignited and the flames extended along the underside of the flooring to a crack nearby, through which they passed and ignited the insulation on the back of the switchboard. The breaking down of the insulation or melting of some connection might have caused a short circuit which disrupted the instrument transformer that furnished current for these circuits, which would allow the 2200 volt power current to flow through a large part of the low tension switchboard wiring and instruments. This high current, with the exterior blaze which was already present, would be sufficient to cause all the damage noted on the board and would also account for the lack of damage to the older part of the control equipment which was not in circuit, while the automatic equipment at both ends of the board was destroyed. The fire evidently communicated through cable openings in the floor to the joists and timbers at the opposite end of the platform from the grid above mentioned and as these were concealed probably burned longer than the fire in other places. The windings of the motor were almost completely consumed but no evidence of excessive heat was apparent on the generator and exciter close by on the same shaft or on the floor near the sets, which shows that the fire did not communicate between the motor and the board but that the damage to the motor was due to the electrical current which was flowing in the windings. It is therefore assumed that the motor failed to rotate, or if it started did not reach synchronizing speed, so that overheating took place in the windings and in the grid of the rheostat resulting in the course of events above described.

Another theory as to the cause of the fire is that the windings of an instrument transformer short circuited, but this would hardly account for the damage to the motor as the main circuit breaker would probably have dropped out immediately and cut off all current.

In conclusion, it should be noted that this station was not in accordance with modern standards either in construction of the building or in arrangement of equipment even for a manually operated station. For an electric station which is to operate without an attendant it is absolutely necessary to eliminate all combustible material from the structure even though all possible protective devices are provided in the equipment. The omission of any of the protective devices which have been devised for isolating or guarding against incorrect functioning or other possible failures of the equipment is poor engineering practice and sooner or later will result in interruptions in service or loss of equipment which will wipe out all of the savings made possible by the automatic control system.

Hammond Lumber Co. Fire.

Report by Oregon Insurance Rating Bureau.

(Member N. F. P. A.)

The plant of the Hammond Lumber Co. at Astoria, Oregon, was destroyed by fire on September 11, 1922, with a loss of approximately $800,000. An interesting feature of the fire was that it started in a sprinklered mill with employees close at hand and ample first aid fire fighting appliances and yet the mill was destroyed. This plant was built in 1903 and the buildings had been remodeled and extended at various times. The cutting capacity was 400,000 feet in ten hours.

The plant comprised both sprinklered and unsprinklered buildings. The office, store, hotel, dwellings, stable and bunk houses were on solid ground and were not sprinklered. These were not burned and will be omitted from the description. The manufacturing part of the plant also comprised both sprinklered and unsprinklered buildings. The sprinklered portion of the plant comprised sawmill, including engine room, lath mill, attic filing room, resaw additions, planing mill, dry kiln and loading sheds; boiler house and shop 20 feet east of sawmill and adjoining sawmill by small frame shed; frame machine shop 10 feet north of sawmill, and frame fuel house 76 feet north of boiler house, with frame lean-to sheds intervening. All formed one fire risk. Three large unsprinklered lumber sheds were west of the sawmill, the nearest one being 45 feet distant. The unsprinklered concrete power house was in the mill group. The buildings comprising mill group were irregular in shape and construction and covered 115,500 square feet under roof. The buildings tended to form a quadrangle with irregular open spaces in the center. The boiler house and dry kilns were in the central portion of the group. All of the manufacturing group were on a wharf with a tide swept open space below. Bulkheading which formerly divided space under the dock into sections, had been mostly washed out by the tides. A cargo dock, which was joined to the plant by a narrow section of platform, was saved.

Construction.

The sawmill section was a two-story frame structure with an attic used as a saw filing room. The roof was composition on ¾ inch sheathing on the older portion and corrugated iron on newer portions. The resaw shed was a two-story frame structure forming communication between the planing mill and the sawmill. The planing mill was a high one-story frame building. The boiler house and the machine shop were one-story frame buildings. The power house was a one-story reinforced concrete structure with a light wooden roof on unprotected steel trusses. The openings to the mill were poorly protected by fire doors.

View of the plant before the fire showing the layout and construction.

Protection.

SPRINKLER EQUIPMENT—The plant was protected by a combination dry-pipe and wet-pipe sprinkler system. Buildings were covered by 3,863 heads on eleven 6-inch, three 5-inch and two 4-inch dry-pipe valves and one 6-inch variable pressure alarm valve. The principal undesirable feature was the large areas in the roof spaces. Typical spacing of heads under the roof was 10 feet between lines and 8 feet on lines. Due to congestion of machinery and narrow bays the spacing on first floor averaged one head per 49 square feet. The greatest number of heads on any one system was 313. On the second floor of the sawmill large communicating areas existed. The only portion below the mill floor which was in use was the conveyor ends and these were sprinklered—the remainder of the space under the dock was unsprinklered. There was no machinery or electric wires under the floor in the vicinity where the fire began. The original sprinkler equipment was installed in 1904, but due to the remodeling of the mill at various times the sprinkler equipment was also remodeled. A few years ago an entire new system of distributing mains was installed. A fire originating in same vicinity as this one, in 1918, opened about 500 heads. The filing room was burned and caused $50,000 loss. The large number of heads opened was caused by a sprinkler riser breaking when a dry valve tripped. The sprinkler heads and pipes in the vicinity of origin of this last fire were comparatively new. The sprinkler equipment graded 76% of standard. The deficiencies were as follows:

Dry pipe systems 5%; large number of heads in one open area, 10%; and unsprinklered space under tide swept bulkheaded dock, 10%.

WATER SUPPLIES—The water supplies were considered satisfactory. The primary supply consisted of three Underwriter fire pumps of 2500 gallons combined capacity. Two of the pumps were usually maintained in operation and one held in reserve. The normal water pressure at the pumps was 80 pounds per square inch. The secondary supply consisted of a new wooden gravity tank of 50,000 gallons capacity located on a hill at the north end of the plant. The tank elevation was 52 feet above the highest line of heads.

WATER MAINS—The sprinklered portion of the plant was supplied by a circulating system composed of 6, 7 and 8-inch pipe and supplied both hydrants and sprinklers. Two fire pumps fed the system by an 8-inch main from the north of the plant. The gravity tank supply was by an 8-inch main from the south side of the plant. One fire pump in the center of the plant supplied water to two sides of the circulating system by a 7-inch main. All mains were wrought iron and supported on the dock.

MAINTENANCE—The fire protection was in charge of the chief engineer who was familiar with its operation. One of the pipe fitters acted as sprinkler caretaker. His first duty was to keep the fire system in order. He regularly made inspection of all sprinkler systems when he came on duty in the morning and before he left in the evening. The maintenance of the sprinkler equipment during the last few years has mostly been good. At time of inspection on August 7, 1922, all previous recommendations had been complied with and the general maintenance was found to be good. At this time the manager agreed to install draft curtains throughout the mill roof in locations pointed out to him. He also agreed to reinstall the bulkheads. Plans were being made for installation of these items when the fire occurred. There was no organization among the mill employees for fighting fire. No rules for blowing down dust from timbers were enforced. In June most of the oily posts in the mill were scraped, washed with lye and painted. The first floor of the mill in the vicinity of origin of the fire was badly congested with machinery.

INSIDE PROTECTION—There were twenty-seven 2½-inch hydrants in the sprinklered portion of the plant and nineteen in the unsprinklered lumber sheds close by. Hydrants were 2½ inches in size and were mostly provided with 2½-inch cotton rubber-lined hose and fitted with ¾-inch nozzles. Inside hydrants were not in all cases advantageously located. About thirty 2½-gallon chemical extinguishers were maintained in service. Inside hydrants were so located that six streams using not more than 50 feet of hose could be used at the location of the origin of this fire.

OUTSIDE PROTECTION—Thirteen double outside hydrants, consisting of 6-inch pipe with two 2½-inch hose outlets were located in the yard about the plant. Three hose carts, each containing 300 feet of hose, were at the plant. Each hydrant was equipped with 50 feet of hose.

Cause of Fire.

Fire originated in a core gear set on the first floor. This gear was composed of a pair of metal bevel gears one of which had inserted wooden teeth. The nature of the gears called for use of considerable graphite and

The progress of the fire thirty minutes after it was first discovered.

grease on them and as they were only partially enclosed the flooring in this vicinity was somewhat soaked with oil. The lower portion of gears extended through the floor a short distance and was boxed in underneath. The gears operated the edger on the floor above and transmitted about 250 H. P. The cause of the fire was undetermined, but it is thought to have been a hot box or friction. The millwrights, whose duty it was to take care of the machinery and who were close by when the fire started, stated their impression was that the fire originated below the floor as there was no discernable blaze around this machinery but instead dense black smoke. The millwright who got the first line of hose into service stated that the first flame he noticed was coming up through the floor around his feet. It was high tide at time of the fire and there was no burnable material below the floor except the floor and piling extending up through water. Indications would point to fire originating above the floor and being swept or blown by the action of the machinery to the space below the floor. A man who was stationed at a pit at the base of the refuse conveyor stated that smoke came from under the floor before it was noticeable on the first floor. The pit was below the level of the mill floor and communicated directly with the tide swept space under the plant.

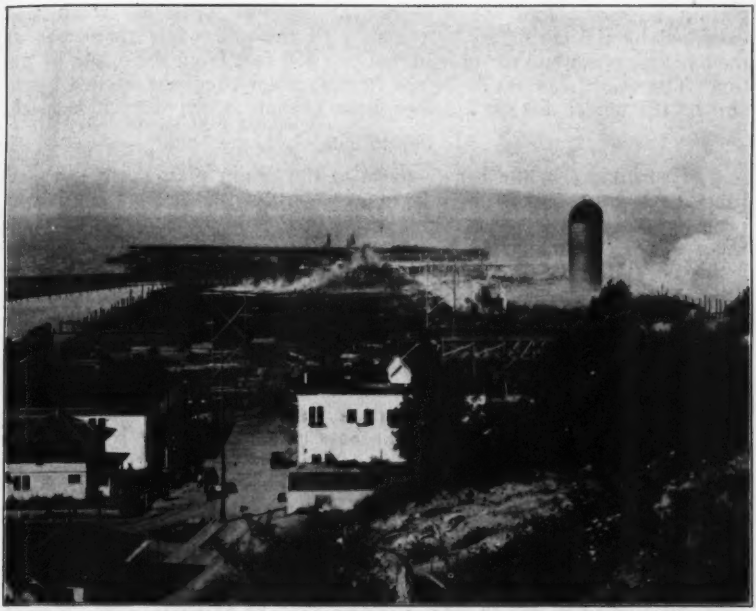
Story of the Fire.

Previous to the fire there had been an exceptionally long dry period without rain. The three days preceding the fire were unusually hot. It

was stated that splinters of the dock would snap when walked upon. Fire occurred at quitting time of the day shift. Millwrights for the second shift were coming on duty and some of them were at a bench 30 feet from where the fire occurred. In going to the bench most of the millwrights passed by the origin of the fire and noticed nothing unusual. Two millwrights were putting on overalls when they noticed dense black smoke in the vicinity of the core gear machinery. These mechanics got 2½-inch hose streams playing on to the smoke very quickly and while they were engaged at this the 5 o'clock quitting whistle blew and was immediately followed by the fire whistle. Those fighting the fire stated that the whole lower floor of mill was full of dense black smoke before any flame was discernible. The smoke quickly drove those who were fighting the fire away and many of the hose streams were left running. The dense smoke permeated the whole mill and when it did break into flame it caused a wave of heat to travel the full length of the high mill roof. The first effort of employees was to get as many hose streams into action as possible. It was a case of every man fighting fire in his own way and it resulted in confusion and waste of water. None of the sprinkler valves were closed to conserve water they were wasting through heads opened by the first big heat wave. All three fire pumps were in operation but maintained their 90-pound pressure for only a few minutes. The city fire department arrived within 15 minutes after the fire began. The fire chief went to the second floor of the mill and found abandoned hose lying around in hopeless confusion. At this time the hose streams in the yard were throwing water only about 25 feet. This would indicate that the water supplies failed to keep up pressure very early in the fire. This was caused by the large number of hose streams in use and by the opening of heads throughout the whole length of the mill roof by the first heat wave thrown up when the dense clouds of smoke, which permeated the building, broke into flame. The mill superintendent stated that he circled the mill early in the fire and shut off 8 or 10 streams that were doing no good but that these were in several instances turned on again after he had left. Many of the employees dropped the hose as soon as the smoke got into their vicinity. When the city fire chief and some mill employees took a line of hose between two rows of burning lumber the crowd shouted for them to come back as they would burn. The men who were shouting took hold of the hose and tried to put the men back. It was with much difficulty that the fire chief stopped the fire at this point. The lack of organization among the mill employees was much in evidence.

Action of Sprinklers.

No one could be found who could give any information regarding the action of the sprinklers at the source of the fire. The men stated that smoke drove them out before the heat opened sprinklers in their vicinity. Many employees witnessed the operation of sprinklers in the roof of the mill in the early stages of the fire. The chief engineer went to the second floor when the fire whistle blew. While he was directing a hose stream on the smoke coming up through the floor he could hear the sprinklers in the roof opening and felt the water coming from them. He had to abandon the hose line and left it running as he could not



The ruins showing complete destruction of the manufacturing buildings.

get to the valve to close it. All of the sprinkler valves which were in the vicinity of the origin of the fire were examined by a Bureau engineer as soon as wreckage could be handled. The interior of the valves indicated that they were in proper order at the time of the fire. Although no evidence could be found that the sprinklers at the origin of the fire did operate neither could any evidence be found that they did not operate. Heads on the same system on the floor above did operate. The failure of the sprinklers to hold the fire can only be attributed to the fire spreading faster than the sprinklers could open. The conditions permitting this were the fire getting under the floor in the unsprinklered space, the dusty condition of the mill and the exceptionally large number of heads in one open area. A local obstruction in the pipe supplying the heads in the vicinity of the origin of the fire would permit a fire to get under headway as this one did. Whether or not the fire originated under the mill floor, it spread to this space very rapidly and filled the mill with gas and smoke. When the gas and smoke did break into flame it had large dimensions. The beams, rafters and structural members of the mill were covered with fine dry wood dust, which was thrown into suspension by currents of air. There were 770 heads in the roof section between the filing room and the north end of the mill. A large proportion of these were undoubtedly opened on the first burst of flame. The rapidity of the spread of the fire is illustrated by the story of the belt man. In the early stage of the fire he was in the belt room

getting belts and tools ready for their removal when his room was drenched by the sprinklers in the roof of the mill. His room was at the extreme north end of the mill and was 350 feet from the origin of the fire. The water supplies could not furnish water to all the opened heads and to the ten or fifteen 2½-inch hose streams which were in service.

Conclusions.

If sprinklers in the dense smoke at the origin of the fire operated properly it will probably never be known. If they did not operate it was probably due to a local obstruction for sprinklers on the same system were reported as operating on the floor above. The extremely rapid combustion at the beginning of the fire indicated that the sprinklers did not function properly or if they did the water did not reach the source of the fire. Many fires have occurred at this plant and have been successfully extinguished by the fire protection provided. Some of these were under less favorable conditions as regards sprinklers and water supplies.

The rapidity with which the plant was destroyed was a surprise to all concerned. That a fire could originate in a sprinklered mill within 30 feet of skilled mill mechanics with ample hose connections close by and with large water supplies available and destroy the mill would be doubted by many who are acquainted with fighting fire. The installation of sprinklers under floors in tide swept spaces is usually impracticable on account of extreme rapid corrosion and the remote possibility of a fire originating in these spaces. The floors and joists in these locations are, however, frequently dry, and without sprinklers underneath to protect them a plant of this kind can in final analysis only be considered as partially sprinklered.

Fertilizer Plants; Fire Record.

The fertilizer industry is somewhat conglomerate as many different substances are used for fertilizing purposes. Artificial fertilizers are prepared to afford either nitrogen, potassium or phosphorus. The various materials used include waste products of slaughter houses, blood, bones, garbage tankage, press cakes, leather scrap, fish scrap, phosphate rock, and pulverized gypsum. These materials are subjected to steaming, grinding, action of chemicals, and other processes to put them in the proper form for use as fertilizer.

The fire records of the N. F. P. A. contain reports of two hundred fires in fertilizer plants. Spontaneous ignition is the most prominent cause of fire in this industry. Spontaneous ignition of fertilizer, tankage, coal, and rubbish caused a total of 57 fires or 39.6 per cent of the fires of known cause. Heating and power are other prevalent common causes. Fertilizer dust is easily ignited and is explosive under the right conditions. There were 14 fires from ignition of dust.

Only a little over a quarter of the fires occurred in sprinklered plants. Most of these were extinguished with small loss.

Classification of Causes.

Common Causes.

	No. of Fires	Per Cent
Heating	17	8.5
Spontaneous Ignition	16	8.0
Power	15	7.5
Open Lights	7	3.5
Sparks from Locomotive	4	2.0
Exposure	3	1.5
Matches—Smoking	3	1.5
Defective Electric Wiring	2	1.0
Explosion	2	1.0
Lightning	1	.5
Sparks on Roof	1	.5
Total	71	35.5

Special Hazard Causes.

	No. of Fires	Per Cent
Spontaneous Ignition of Fertilizer	25	12.5
Spontaneous Ignition of Tankage	16	8.0
Explosion or Ignition of Dust	14	7.0
Foreign Substance in Grinder	5	2.5
Overheating of Fertilizer	3	1.5
Friction in Screening Machine	4	2.0
Electric Insulation Decomposed by action of Fertilizer	2	1.0
Ignition of Chemical	1	.5
Miscellaneous	3	1.5
Total	73	36.5
Unknown Cause	56	28.0
Total	200	100.0

Loss Data.

	Sprinklered	Unsprinklered	Total
Loss Less $1000	41	44	85
Loss More $1000	11	91	102
No Data	0	23	23
Total	52	158	200

Sprinkler Record.

Effect of Sprinklers.		Number of Heads Opened.	
	No. of Fires	Heads	No. of Fires
Extinguished Fire	26	1	11
Held Fire in Check	11	2-5	13
Unsatisfactory	3	6-10	4
Not a Factor	12	11-25	6
		26-100	4

Interesting Fires in Fertilizer Plants.

Spontaneous Ignition of Tankage.

H-157. The fire occurred in a one-story frame metal clad structure, one end of which extended over a river. The building was used for storage of fertilizer and raw stock. About 225 tons of whale meat tankage had been delivered to the plant a few months before and was stored in this building. The whale meat tankage was delivered in bags and appeared to be perfectly dry when received. It is very likely that it absorbed considerable moisture from a severe rain the week previous to the fire, the rain seeping in by way of an outside platform and coming in contact with the bottom of the pile, causing fermentation and finally spontaneous ignition.

Whale meat tankage contains about 12½ per cent of ammonia and 3½ per cent of the bone phosphate of lime. After being thoroughly cooked and pressed to extract the oil, it is dried by machine and granulated, the product resembling finely ground fish scrap.

About half of the building was destroyed and a good part of the contents fell into the river. There was no private fire protection and the fire was finally extinguished by the fire department.

It is concluded that (1) whale meat tankage should be stored only in small quantities in buildings, and then only when perfectly dry; periodical tests should be made to note any rise in temperature; (2) practically total losses of stock may be expected when stored in frame buildings over water.

H-5981. Fire was discovered at midnight by a watchman in a pile of packing house tankage. The storage building took fire and the entire plant was destroyed. Packing house tankage is made from refuse, such as scraps of meat, bones, waste blood, grease and other offal products, from which, after being cooked, the grease is pressed out. The remaining cake is crushed, dried and ground. Part of the pile of tankage where the fire was found had not been ground.

When the grease is not completely pressed from tankage cake, the tankage is susceptible to spontaneous heating. The greater the amount of grease the more accelerated is the action, especially when the tankage is not thoroughly dry. It is probable that a leaky roof and bad weather conditions previous to the fire were responsible for moistening the tankage.

H-15622. The plant was a group of frame buildings used for mixing fertilizer. The watchman smelled garbage tankage burning and on investigation he found some bags steaming. As it did not appear serious he proceeded on his rounds. When he returned he found the wooden wall in flames and he immediately turned in the alarm.

The fire department was hindered by the inaccessibility of the plant and the main building was badly damaged.

It was stated that this pile of garbage tankage was found to be heating up the day before the fire and several bags were moved at that time.

Heating.

H-12337. The fire started in the steam heated dryer in the frame rendering building. Scrap horn is purchased by this concern from fac-

tories that use both horn and celluloid. This scrap is ground and dried and is then called horn meal fertilizer. It is believed that some celluloid scrap became mixed with the horn and that when put in the dry room it was ignited by the steam pipes.

Thermostats were located on the second floor of the building so the fire had to burn through the floor before the system operated. Employees tried to send in an alarm but the box did not operate. This delay allowed the fire to gain headway and several buildings were destroyed.

Ignition of Dust.

H-8999. The fire occurred in the basement of a frame mill used for storage of ground bone and finished fertilizer. It was discovered near the bone mill. This machine consists of two steel cages (one inside the other) rotating in opposite directions. The bone is conveyed by an endless belt under magnets before passing into the mill, but it is believed that some foreign substance entered the mill and a spark ignited the dust. The fire spread very rapidly, attacking other frame buildings before the fire department arrived.

Electric Wiring.

H-1568. The fire started in a storage room of open joist construction. Mixed fertilizer, in bulk, was piled to the ceiling. The fertilizer covered some electric light wires. These wires were rubber covered and the insulation was completely burned off due to the action of the fertilizer. Two tons of fertilizer were destroyed and 25 tons badly damaged. The fire was extinguished by a private hose stream.

Hot Cinders.

H-8779. The fire started on the top floor of a frame tower used to load slag into cars, in the sulphuric acid manufacturing section of a phosphate rock fertilizer plant. Sulphuric acid is used to form phosphoric acid from the phosphate rock (calcium phosphate). The cinders from the sulphur ore in the wedge burners are conveyed to the top of the tower. The cinders were not cooled before elevating and set fire to the frame structure. From here the fire spread to acid towers and acid chamber buildings, which were totally destroyed.

Two Recent Factory Fires.

Two factory fires, occurring within a few days of each other in buildings of the same type of construction and both involving loss of life, have recently been reported by the New York Board of Fire Underwriters (Member N. F. P. A.).

The first occurred on October 30, 1922, at 6:30 P. M., in a tenant manufacturing building at 126-142 Thirteenth Street, Brooklyn. In this fire one man lost his life and eight persons were injured.

The second occurred on November 3, 1922, at 1:14 P. M. in a tenant manufacturing building at 16 East 13th Street, New York. In this fire five girls perished.

The Brooklyn Fire.

The building was a five-story ordinary brick building in fair repair. The walls were 12-inch brick, partitions frame. The stairs and hallways were enclosed by wooden construction. There was a smoke-proof stair tower in the rear with flat framed iron doors between the tower and an iron balcony and sub-standard metal covered doors between balconies and lofts on each floor. The stairs were of iron with concrete landings.

The building was occupied in the basement and first two floors by a firm engaged in grinding and mixing shellac. The three upper floors were occupied by clothing manufacturers.

The origin of the fire is unknown. Owing to the destruction of the upper floors of building, the point at which the fire started could not be located, but from statements of witnesses, it apparently started at a point on the third floor close to the poorly protected elevator shaft located approximately at center of building.

The fire spread throughout the third floor and entire upper portion of building; also to second floor, with considerable ease and rapidity, apparently due to unprotected or poorly protected floor openings.

The fire was discovered burning on the third floor by a clerk employed in the building, but evidently not until it had gained considerable headway. Three alarms were turned in from box 332 located on the southwest corner of 3rd Avenue and 13th Street, at 6:30, 6:34, 6:36 P. M., respectively, which brought considerable apparatus to the scene.

Half of the third and practically the entire fourth and fifth floors and roof were destroyed, and the contents of the lower floors were damaged by smoke and water.

One person, a man, lost his life in this fire when he jumped from a window on the fifth floor. There were also eight other persons injured and removed to hospitals. The loss of life can only be attributed to panic and the fact that the smoke-proof stair tower located at the rear of the building was not utilized to the extent it should have been, due to smoke from the lower floors passing up through the open gratings of the plat-

forms. This drove some of the occupants back into the building when they tried to escape by way of the smoke-proof tower.

The necessity of automatic sprinklers and adequate protection of all floor openings in a building of this type is clearly demonstrated by this fire. Balcony platforms of smoke-proof towers and space below hand rails should be of solid material and not of open gratings.

The Thirteenth Street Fire.

This building was a converted dwelling, five stories in height. The walls were of brick and the finish of wood lath and plaster. The stairways were enclosed by lath and plaster partitions with wooden doors to floors. The basement was unused. The first floor was occupied by a binding company and the second by a clothing manufacturer. The third floor was occupied by a manufacturer of hair ornaments composed of pyroxylin plastic. The two upper floors were used by a firm making uniform braids. Part of the third floor was used for decorating pyroxylin plastic combs with lacquer or enamels thinned with volatile inflammable solvents. The operation being carried on where the fire started was drilling small holes in the combs and inserting rhinestones. The rhinestones were heated on an electric hot plate. Apparently some of the combs that were in process, and lying near or on the stove, became overheated and burst into flame, the fire flashing over the portion (about 400 square feet) occupied by stock in cartons on wooden shelves and stock in process The fire burned very rapidly and extended to the floors above by way of the lath and plaster hallway.

The first alarm was given by an outsider, followed shortly after by a man on the premises who noticed the fire at the electric stove and who then tried to beat out the flames. The upper floors were in flames when the first apparatus arrived.

Five girls employed by the uniform braid manufacturer lost their lives, apparently through becoming panic stricken, as they were urged to go to the roof and escape to the adjoining building of the same height. Some did escape in this manner.

The contents of the upper three floors were practically destroyed.

Pyroxylin plastic novelty manufacturers should be located only in fire-resistive buildings equipped with approved systems of automatic sprinklers. This fire strongly emphasizes the importance of early adoption of the proposed ordinance which will give local authorities power to regulate such establishments.

Woodworkers: Fire Record.

A fire record of woodworkers, including 365 fires, was published in *Special Hazard Bulletin No.* 14 (July, 1906). This record has been brought up to date and the tables herewith include 1688 fires which have occurred during the years 1906 to 1921, inclusive.

For purpose of analysis the woodworkers are divided into six classes which are as follows:

CLASS A: Interior Woodwork, builders' supplies (including veneer works).

CLASS B: Box Factories (including cigar boxes).

CLASS C: Miscellaneous woodworkers, steam power tenant woodworkers (also woodworkers where there is a lack of detailed information as to class).

CLASS D: Sash, Door and Blind Factories.

CLASS E: Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

CLASS F: Pails and Woodenware (plates, wooden bowls, tubs, etc.).

Each of these classes is treated separately in the fire record, the number of fires in each class being as follows:

Class A.....	364	Class D.....	274
Class B.....	404	Class E.....	355
Class C.....	217	Class F.....	74

As might be expected in an industry where large quantities of wood, sawdust, and other inflammable material are necessarily present and such waste materials generally used for fuel, fires due to sparks from boilers are most common. Nearly a third of the fires due to common causes are in this class. Power is the second largest common cause of fires. Friction, overheated bearings and hot boxes are prolific sources of fire, especially when there is a layer of wood dust on the shafting and bearings. The fact that rubbish and "smoking—matches" are prominent common causes is an indication that the ordinary precautions so important to the safety of such a hazardous industry are not always taken.

Of the special hazard causes, fires originating in the dry kiln and in the shavings vault are most common. The exact causes of these fires are usually not ascertainable, but undoubtedly many of them are due to faulty construction or protection.

It should be noted that the forty-seven fires listed under miscellaneous special hazard causes were due to such diversified causes that it is impossible to group them in any common classifications. This is an indication of the many possible chances for fire in the woodworking industry.

In twenty-five per cent of the fires recorded the cause was unknown. This percentage is high, but undoubtedly due to the fact that a fire in this occupancy is usually severe, spreads rapidly, and exact causes consequently difficult to establish.

Woodworkers—Fire Record.

Total Number of Fires Reported 1688.

Classification of Causes.

Common Causes.

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Boiler or Fuel...	59	32.9	92	39.3	42	34.7	45	31.0	52	26.5	10	27.0	300	32.9
Power	30	16.7	31	13.2	14	11.6	21	14.5	25	12.8	16	43.3	137	15.1
Rubbish or Oily Material	23	12.8	15	6.4	15	12.4	18	12.4	35	17.9	0	0	106	11.6
Smoking—Matches	12	6.7	20	8.6	10	8.3	10	6.9	25	12.8	1	2.7	78	8.5
Chimney or Flue.	6	3.3	13	5.6	8	6.6	10	6.9	12	6.1	0	0	49	5.4
Exposure	9	5.0	14	6.0	9	7.4	8	5.5	5	2.5	2	5.4	47	5.1
Incendiary	11	6.1	15	6.7	2	1.6	9	6.2	7	3.6	0	0	44	4.8
Lighting	5	2.7	8	3.4	3	2.5	10	6.9	10	5.1	1	2.7	37	4.1
Locomotive Sparks	6	3.3	11	4.7	7	5.8	1	.7	6	3.0	1	2.7	32	3.5
Heating	4	2.2	6	2.6	4	3.3	3	2.1	6	3.1	4	10.8	27	3.0
Lightning	7	3.9	2	.9	3	2.5	1	.7	7	3.6	2	5.4	22	2.4
Spontaneous Ignition	3	1.7	4	1.7	3	2.5	6	4.1	4	2.0	0	0	20	2.2
Miscellaneous ...	5	2.7	2	.9	1	.8	3	2.1	2	1.0	0	0	13	1.4
Total	180	100	233	100	121	100	145	100	196	100	37	100	912	100

Special Hazard Causes.

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Dry Kiln (exact cause unknown)	44	57.1	15	21.7	14	29.8	9	20.4	22	23.9	9	45.0	113	32.4
Shavings Vault (exact cause unknown)	18	23.4	37	53.6	15	31.9	17	38.5	9	9.8	4	20.0	100	28.5
Blower System...	4	5.2	4	5.8	1	2.1	3	6.8	7	7.7			19	5.5
Sanding Machine.	2	2.6			2	4.3	4	9.1	7	7.7	2	10.0	17	4.9
Dust Collector...	2	2.6	1	1.5			1	2.3	5	5.4			9	2.6
Turning									8	8.7	1	5.0	9	2.6
Gasoline Torch...					3	6.4	1	2.3	3	3.1			7	2.0
Boring and Reaming			2	2.9					4	4.3			6	1.7
Sawing and Planing			2	2.9	1	2.1			2	2.2			5	1.4
Glue Pots	1	1.3			3	6.4	1	2.3					5	1.4
Dust Explosion...	1	1.3					3	6.8					4	1.1
Refuse Burner...			1	1.5							1	5.0	2	.6
Cementing									2	2.2			2	.6
Buffing Dust									2	2.2			2	.6
Sawdust Feed Pipe			2	2.9									2	.6
Miscellaneous ...	5	6.5	5	7.2	8	17.0	5	11.5	21	22.8	3	15.0	47	13.5
Total	77	100	69	100	47	100	44	100	92	100	20	100	349	100

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Common Causes	180	49.5	233	57.6	121	55.7	145	52.9	196	55.3	37	50.0	912	54.1
Special Hazard Causes	77	21.2	69	17.1	47	21.6	44	16.1	92	26.0	20	27.0	349	20.7
Unknown Cause	107	29.3	102	25.3	49	22.7	85	31.0	67	18.7	17	23.0	427	25.2
Total	364	100	404	100	217	100	274	100	355	100	74	100	1688	100

Sprinkler Record.

Effect of Sprinklers.*

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Extinguished Fire	102	55.8	110	55.0	69	57.5	62	59.7	131	65.8	26	63.4	500	59.1
Held Fire in Check	58	31.7	71	35.5	44	36.7	28	26.8	59	29.7	13	31.7	273	32.2
Unsatisfactory...	23	12.5	19	9.5	7	5.8	14	13.5	9	4.5	2	4.9	74	8.7
Total	183	100	200	100	120	100	104	100	199	100	41	100	847	100

* There were 158 fires in which the sprinklers did not operate, either by reason of prompt extinguishment of fire by other means, or fire occurred in unsprinklered portions.

Comparison of Wet and Dry Sprinkler Systems.

Wet Systems.

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Extinguished Fire	60	68.9	48	57.8	41	55.3	29	70.8	94	65.3	8	47.0	280	62.7
Held Fire in Check	21	24.2	28	33.7	30	40.6	6	14.6	45	31.2	9	53.0	139	31.2
Total Satisfactory	81	93.1	76	91.5	71	95.9	35	85.4	139	96.5	17	100	419	93.9
Unsatisfactory...	6	6.9	7	8.5	3	4.1	6	14.6	5	3.5			27	6.1
Total	87	100	83	100	74	100	41	100	144	100	17	100	446	100

Dry Systems.

Extinguished Fire	42	45.2	62	53.9	26	59.1	33	54.1	36	66.7	18	75.0	217	55.5
Held Fire in Check	37	39.8	43	37.4	14	31.8	22	36.1	14	25.9	4	16.7	134	34.3
Total Satisfactory	79	85.0	105	91.3	40	90.9	55	90.2	50	92.6	22	91.7	351	89.8
Unsatisfactory...	14	15.0	10	8.7	4	9.1	6	9.8	4	7.4	2	8.3	40	10.2
Total	93	100	115	100	44	100	61	100	54	100	24	100	391	100

Number of Sprinkler Heads Operating. (Average 13.)

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
Sprinklers Number	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
1	42	24.7	44	22.9	38	31.8	21	21.9	81	41.7	8	20.3	234	28.8
2	33	19.5	38	19.8	24	20.0	21	21.9	42	21.6	4	10.3	162	19.9
3	19	11.2	22	11.5	11	9.3	6	6.3	17	8.7	1	2.6	76	9.4
4	14	8.2	10	5.2	5	4.2	6	6.3	10	5.1	4	10.3	49	6.0
5	5	2.9	8	4.2	6	5.0	3	3.1	6	3.1	4	10.3	32	3.9
6	5	2.9	8	4.2	4	3.3	5	5.2	5	2.6	2	5.1	29	3.6
7	4	2.3	4	2.1	3	2.5	3	3.1	5	2.6	2	5.1	21	2.6
8	1	.6	5	2.6	4	3.3	4	4.3	2	1.0	4	10.3	20	2.5
9	1	.6	7	3.6	1	.8	3	3.1	2	1.0			14	1.7
10	3	1.8	2	1.0	3	2.5	2	2.1	5	2.6	1	2.6	16	2.0
11	2	1.2	3	1.6	1	.8	3	3.1	2	1.0			11	1.4
12	6	3.5	1	.5	4	3.3			2	1.0	1	2.6	14	1.7
13	1	.6	4	2.1	2	1.7	1	1.0	1	.5			9	1.1
14	3	1.8	2	1.0	1	.8	1	1.0	2	1.0			9	1.1
15	4	2.3	2	1.0	1	.8							7	.9
16 to 20	6	3.5	8	4.2	3	2.5	3	3.1	3	1.5	3	7.6	26	3.2
21 to 25			5	2.6			3	3.1	4	2.0	1	2.6	13	1.6
26 to 30	1	.6	3	1.6			2	2.1	2	1.0			8	1.0
31 to 35	3	1.8	2	1.0							1	2.6	6	.7
36 to 40	2	1.2	2	1.0	1	.8	1	1.0					6	.7
41 to 50	5	2.9	1	.5	1	.8	3	3.1	2	1.0	2	5.1	14	1.7
51 to 75	2	1.2	3	1.6	2	1.7	3	3.1			1	2.6	11	1.4
76 to 100	2	1.2	3	1.6	1	.8							6	.7
101 to 200	5	2.9			1	.8			1	.5			7	.9
201 to 300	1	.6	1	.5	2	1.7	2	2.1	1	.5			7	.9
Over 300			4	2.1	1	.8							5	.6
Total	170	100	192	100	120	100	96	100	195	100	39	100	812	100

Note: In eight fires all heads opened. No data as to number.

Miscellaneous Statistics.

Analysis of Loss.*

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Sprinklered Fires														
Large Loss	26	12.4	23	9.6	11	7.9	16	12.2	18	7.6	3	6.0	97	9.6
Small Loss	179	85.7	216	90.0	127	91.4	114	87.0	218	92.4	47	94.0	901	89.7
No Data	4	1.9	1	.4	1	.7	1	.8					7	.7
Total	209	100	240	100	139	100	131	100	236	100	50	100	1005	100
Unsprinklered Fires														
Large Loss	100	64.5	82	50.0	40	51.4	100	69.9	65	54.6	13	54.2	400	58.6
Small Loss	46	29.6	69	42.1	29	37.1	34	23.8	44	37.0	8	33.3	230	33.7
No Data	9	5.9	13	7.9	9	11.5	9	6.3	10	8.4	3	12.5	53	7.7
Total	155	100	164	100	78	100	143	100	119	100	24	100	683	100

* Large loss fires are fires causing damage greater than $5000.00.

How Discovered.

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Employee	136	37.2	137	33.8	85	39.1	85	31.1	125	35.2	40	54.0	608	36.0
Watchman	90	24.8	112	27.7	46	21.2	67	24.4	71	20.0	16	21.6	402	23.8
Sprinkler Alarm	37	10.2	45	11.2	31	14.3	25	9.1	63	17.8	7	9.5	208	12.3
Outsider	84	23.1	74	18.3	39	18.0	82	29.9	70	19.8	6	8.1	355	21.0
Thermostat	2	.6	6	1.5	5	2.3	3	1.1	14	3.9	4	5.4	34	2.1
Supervisory System			8	2.0	3	1.4	1	.4	3	.8			15	.9
No Data	15	4.1	22	5.5	8	3.7	11	4.0	9	2.5	1	1.4	66	3.9
Total	364	100	404	100	217	100	274	100	355	100	74	100	1688	100

Day or Night Fires. (Day Fires 6 A. M. to 6 P. M.)

Day	167	45.9	175	43.3	104	48.0	109	39.9	152	42.8	41	55.4	748	44.3
Night	184	50.6	215	53.3	111	51.1	155	56.5	197	55.5	29	39.2	891	52.8
No Data	13	3.5	14	3.4	2	.9	10	3.6	6	1.7	4	5.4	49	2.9
Total	364	100	404	100	217	100	274	100	355	100	74	100	1688	100

Room in Which Fire Occurred.

	Class A		Class B		Class C		Class D		Class E		Class F		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Boiler or Engine Room	72	19.8	103	25.6	47	21.7	48	17.4	67	18.8	13	17.6	350	20.8
Shavings Vault	27	7.4	63	15.6	24	11.0	29	10.6	8	2.2	6	8.1	157	9.3
Dry Kiln	52	14.3	23	5.7	20	9.2	12	4.4	27	7.6	12	16.2	146	8.7
Main Work Room	16	4.4	18	4.5	10	4.6	15	5.5	16	4.5	3	4.0	78	4.6
Storage Room	13	3.6	17	4.2	9	4.2	16	5.9	18	5.1	4	5.4	77	4.6
Basement	24	6.6	10	2.4	9	4.2	9	3.3	15	4.2	2	2.7	69	4.1
Roof	11	3.0	14	3.4	10	4.6	10	3.7	13	3.7	1	1.4	59	3.5
Sawing and Planing	14	3.8	8	2.0	2	.9	13	4.7			2	2.7	39	2.3
Yard	5	1.4	12	3.0	3	1.4	9	3.3	4	1.1	1	1.4	34	2.0
Finishing	9	2.5			7	3.2	3	1.1	9	2.5	1	1.4	29	1.7
Miscellaneous	29	8.0	33	8.0	23	10.5	27	9.9	58	16.5	10	13.4	180	10.6
No Data	92	25.2	103	25.6	53	24.5	83	30.2	120	33.8	19	25.7	470	27.8
Total	364	100	404	100	217	100	274	100	355	100	74	100	1688	100

Approximately thirty per cent of the fires recorded show a loss of over $5000. It is interesting to note that only 9.6 per cent of the sprinklered fires were large loss fires (over $5000) while 58.6 per cent of the unsprinklered fires were of large loss. Class A and Class E have a higher percentage of large loss fires than the other classes.

The sprinkler record is very satisfactory, considering the serious hazard involved. Over ninety per cent of the sprinklered fires were extinguished or held in check by the sprinklers. A comparison of wet and dry systems shows that the wet system has a slightly better record of operation. 10.2 per cent of the dry system fires were unsatisfactory as compared with 6.1 per cent of the wet system fires.

The average number of sprinkler heads opening per fire was thirteen. This figure is higher than the average of most other industries. Such a figure is a fairly good index of the relative hazard of the various industries. It is worthy of note that Class E had a considerable number of fires extinguished by one sprinkler head, an indication that sprinkler protection is particularly valuable for this class.

Some Typical Fires in Woodworkers.

Dry Kiln.

S-25212: WOODWORKER CLASS B. The fire occurred in the dry room on the first floor of a two-story building of wooden walls, steel sheathing and concrete blocks, occupied by a box and butter tub mill. The fire was discovered by several employees when flames burst out from a long frame metal lined veneer dryer. This dryer was about 100 feet long and 13 feet wide. There were 14 fans within the dryer and it is believed that a hot bearing on one of the fans caused the fire. There were forty-two 360° sprinkler heads in the dryer but the operation of these was slow and unsatisfactory. Before the fans could be shut off the fire spread so quickly that men on the second floor had to jump from the windows to escape. Within 20 minutes the south half of the plant was destroyed and in one hour the whole plant was burned to the ground. The sprinklers in the mill operated but the fire was beyond their control. The lessons of this fire are that only dryers of fire resistive construction are suitable for this process and that the plant should have been cut into sections by standard fire walls.

S-20670: WOODWORKER CLASS E. The plant was a three-story wooden building occupied as a spool and bobbin factory. The fire started about 9 A. M. in a dry room on the second floor. The dry room was filled with bobbin stock, heated by superheated steam, and was built of boards with hollow walls. The heat had shrunk some of the boards so there were cracks between them. The fire passed up through the hollow partition to the dryer above and also out through the cracks into an unsprinklered room. The sprinklers failed to hold the severe fire which gained rapid headway in the unsprinklered room and was soon beyond control. The loss on building and contents was nearly total.

H-16593: WOODWORKER CLASS B. The plant was an unsprinklered box factory. The buildings were all of frame construction except the boiler house and there were no fire walls or open spaces between buildings or between buildings and lumber piles. The fire started in the dry kiln

before the plant had opened for the day and was discovered by an outsider. All the buildings were on fire when the apparatus arrived. There was not much wind and the water supply was adequate, but it was only after a fight of two hours that part of the lumber was saved.

S-33293: Woodworker Class A. Fire starting at 8 P. M. destroyed the dry kilns and saw and planer room. These buildings were one-story, of hollow concrete block and ordinary joisted construction, the kilns separated into six compartments, which opened into the saw and planer room and were separated from it only by canvas curtains. The saw and planer room communicated directly with the two-story factory building through large unprotected openings in concrete block panel walls; large window openings in the factory overlooked the roof of the saw and planer room.

These buildings were fully sprinklered. Men were working overtime in various portions of the plant and observed fire burning through the curtain of the kiln. Within a very short time the fire belched out into the saw and planer room and by the time the volunteer fire department arrived this room and all the kilns were involved. The sprinklers on both floors of the factory were operating and with the help of hose streams the fire was prevented from entering. The sprinklers in the dry kilns and saw and planer room apparently did not operate, probably because the gate valve was closed.

Boiler.

H-14450: Woodworker Class A. The fire started in the boiler house of a frame veneer mill. A flare back from the boiler set fire to some wood refuse used for fuel. A sprinkler system had been installed for nearly a year but was without any water supply. The fire pump which was to have served as a supply was not in commission. There being no public fire department available the fire was fought by a bucket brigade but it broke through the boiler house and communicated to the main mill. Once in the mill the fire spread with great rapidity and the entire plant was destroyed.

H-12991: Woodworker Class D. The plant consisted of one and two-story frame buildings occupied by a sash and door factory. Sparks from the boiler set fire to dust on the outside of the cyclone dust collector and before this fire could be extinguished an explosion of dust took place throwing the fire into the factory adjoining. The fire gained such headway in the building, which was unsprinklered, that men scarcely had time to escape. The factory was very dusty and the fire flashed through all rooms, being beyond control by the time the fire department arrived. The loss was total.

Heating.

S-32647: Woodworker Class A. The fire took place in a three and four-story brick and wood building occupied on the third floor by a firm making interior wood trim. The fire started at 7:05 P. M., in a wooden ventilator from a gluing and drying room, and was due to steam pipes which were in close contact with dry woodwork and wood dust. The sprinklers in the dry kiln operated and the sprinkler alarm worked satis-

factorily. The fire worked through the roof, owing to poor spacing of sprinklers, and set fire to woodworking refuse in the blower pipes passing over the roof. Sparks fell into the vents of the cyclone dust collectors over the shavings vaults causing considerable trouble and necessitating the cutting of the steel blower pipes. The fire was extinguished and sprinkler equipment restored at 11:02 P. M. At 1:02 A. M. a sprinkler alarm was again turned in and it was found that a fire had started in a sander on the third floor. As nearly as could be ascertained the very fine dust from the sander had been ignited in the dust collecting system and flashed back to the machine. Eight sprinklers in the blower room and four sprinklers over the sander opened. They held the fire in check but could not entirely extinguish it on account of obstructions.

Spontaneous Ignition.

S-33267: WOODWORKER CLASS A. The fire occurred at 9:31 P. M. in the paint shop of a woodworker making interior trim and cabinet work. The building was a two-story frame structure. The cause of the fire was spontaneous heating of painter's material and refuse under a wooden bench. Owing to poor spacing and water supply to sprinklers there was sufficient heat to open 21 out of 28 sprinklers in the room. The actual fire damage was small but water damage was considerable. The watchman failed to discover the fire, the outside rotary gong was found full of mud and the main gate valve failed to close entirely, all of which contributed to the water damage.

Blower System.

S-33069: WOODWORKER CLASS E. The fire occurred on the second floor of a frame steel clad shavings room of a plant manufacturing wooden toys. An employee in the reinforced concrete shavings vault stated that a small amount of burning material came down from one of the cyclone separators on the roof of the vault. The cause of the fire was presumably a spark from some foreign material in one of the blowers. The air of the vault being full of wood dust the fire spread immediately to a small two-story frame steel clad baling room adjoining and then over the entire warehouse and woodworking building within one or two minutes. These buildings were not sprinklered and were destroyed. The main building was protected by sprinklers, wired glass windows and standard fire doors; this building was saved although some of the wired glass windows were melted and the heat opened some sprinklers adjacent to the windows.

Glue Pot Heater and Alcohol.

H-15657: WOODWORKER CLASS C. The fire started in the work shop devoted to repairing, polishing and touching up of furniture. The falling of a chisel from a tool rack broke a bottle containing alcohol. The vapor came in contact with the flames of a gas radiator nearby which was used for heating a glue pot. The ensuing fire burned very rapidly as the building was of wooden construction and was filled with inflammable material. The building was destroyed.

Lexington Avenue Apartment House Fire.

Report by New York Board of Fire Underwriters.

(Member N. F. P. A.)

Fire occurring in a five-story apartment house at 1769 Lexington Avenue and 150 East 110th Street, New York, on October 22, 1922, at 1:03 A. M., caused the death of fifteen tenants. The building was occupied by a cigar store, restaurant and barber shop on the first floor and by apartments on the upper floors, three families to a floor. The principal fire hazards were usual gas heated appliances in the restaurant and barber shop and small gas ranges for each tenant.

There was no inside protection. There were three outside fire escapes of the vertical ladder type, one for each tenant.

Construction.

The building was of ordinary brick construction, five stories in height and covered an area of 2,375 square feet. The walls were brick. The partitions throughout, dividing floors into numerous rooms, were lath and plaster on wooden studs. The roof was metal on wood boards and joists. Cornices were of metal. There were skylights of thin glass over the air shaft. The floors were single 7/8-inch boards on wooden joists. The ceilings were ordinary lath and plaster except part metal on the first floor. There was one wooden stairway, continuous from the first to the third floor, with the flights directly over each other and enclosed in a lath and plaster hallway. There was one air shaft of 3-inch plaster block in angle iron frame running from the first floor through to the roof with three large thin glass window openings to each floor.

Story of the Fire.

It was stated that an alarm was anonymously phoned to the Police Headquarters, who in turn informed the Fire Department at the same time that an alarm was received from Box 1344, located at Lexington Avenue and 111th Street, about one block distant. This alarm was received at 1:03 A. M., and immediately upon arrival of the Fire Department a second alarm was turned in at 1:09 A. M. from Box 1328, located at Lexington Avenue and 109th Street, and finally a third alarm was turned in from this same box at 1:28 A. M.

There evidently was considerable loss of time before an alarm was turned in. This apparently is due to the fact that it was late at night, also that the stairway was situated at the rear of the building and reached by a comparatively long hallway. It was at the rear end of this hallway that the fire is thought to have started and it could easily have gained considerable headway before it would be noticed by persons on the street.

The fire apparently originated in the hallway on the first floor of the building from a cause not definitely known. The remnants of a baby

carriage were found in approximately the spot where the fire originated and it is the general opinion that a lighted cigarette or cigar may have been thrown by someone into this carriage as they went up the stairs.

The fire spread rapidly through the hallway containing the stair shaft to all floors above the first and through the roof. When the first of the Department's apparatus arrived, all of the floors above the first were in flames.

Loss of Life.

A total of fifteen persons lost their lives in this fire. The firemen made heroic attempts to save the occupants and did succeed in rescuing many. Twelve persons were unable to leave the building and perished in the flames, two people were killed when they jumped from the building and one person died of injuries after removal to the hospital. There were also eleven persons, varying in age from two to eighty-five years, injured and removed to hospitals. The charred remains of those killed in the building were removed from the third floor center and the fourth and fifth floors at north and center. Owing to the start of the fire at the bottom of the stairway, this means of escape was cut off almost immediately and the fire escape was apparently cut off soon after. The three fire escapes were of the vertical ladder type and accessible only from one window opening to the kitchens of each apartment. In order to reach two of the fire escapes, it was necessary for the occupants to first pass into the hallway, where the fire was burning, and then into the kitchens, as the kitchens did not communicate directly with the other rooms of the apartments. The fire escapes also passed directly in front of unprotected windows on lower floors, and owing to the fact that the fire was burning on these floors first, they could not be used. The building was situated on a corner and adjoined another building on part of each side only, but escape to that building was practically impossible as the roof was much lower and the windows were on a different level.

Conclusions.

The inflammable construction of stairs, stair enclosure, and partitions, undoubtedly contributed largely to the rapid spread of the fire. The importance of having the stairs enclosed in a shaft of fireproof construction with fire doors at all openings to inside of building is apparent.

The location of two of the fire escapes in such a position that they were accessible only from one window in a room which did not communicate directly with the other rooms, was the principal cause of the large loss of life. Fire escapes of vertical ladders, and so placed that they pass directly in front of unprotected windows on lower floors, are obviously of little or no value.

The lessons of this fire have long since been learned and the defective conditions which contributed to the loss of life in this case have for a long time been prohibited by law in the erection of new buildings.

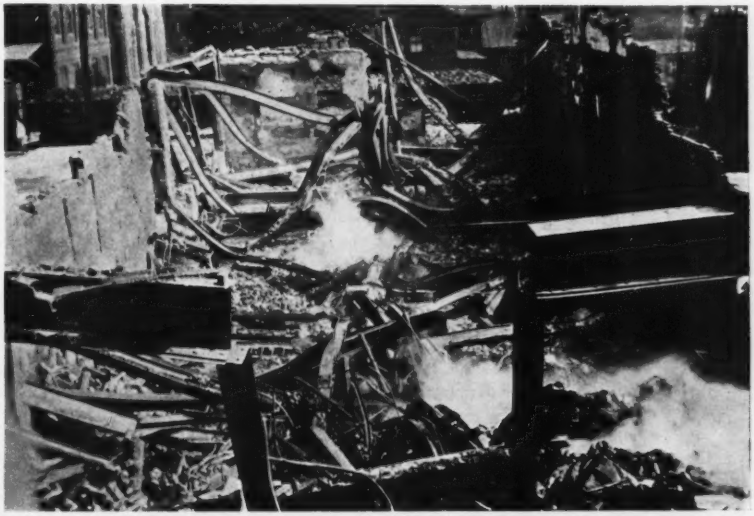
Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Mercantile Building.

H-18904. LOGAN, W. VA. At 5:00 A. M. Sunday, September 3, 1922, fire broke out in the basement of the White-Browning Building, located in the business district of Logan, W. Va., resulting in the total destruction of the building, exposure damage to several nearby buildings, and the loss of one life.

The building, of ordinary brick-joisted construction, was fairly new and in good repair. It was one and five stories high, 70 x 120 feet in size. It was detached thirty feet or more from surrounding buildings.



The ruins of the White-Browning Building, Logan, West Virginia. A boy was burned to death in a pool room in the basement.

The building was occupied as follows: Pool room and bowling alley in basement, furnishings, groceries and drugs on first floor, telephone exchange office on third floor, and offices on second, fourth and fifth floors.

The fire was first discovered at 5:00 A. M. by girls working in the telephone exchange on the third floor of the building, who could smell smoke but could not discover the cause. The alarm was turned in by

telephone. The volunteer fire department arrived and played a stream of water into the basement of the building through a window from which clouds of smoke were issuing.

Hearing that a fifteen-year-old boy was sleeping in the rear of the pool room in the basement, two firemen dashed into the building, found the boy's bed empty and untouched by fire, and made a futile attempt to discover the whereabouts of the boy and the source of the smoke. Apparently the boy had become bewildered and was burned to death while trying to escape.

Water was played into the basement for about an hour, after which time smoke ceased to come from the basement, spectators returned to their homes, and the firemen thought that they had extinguished the fire. Up to this time very little damage had been done and only smoke had been seen, no fire being visible. The firemen remained on the job and attempted to discover the source of the smoke.

At about 7:00 A. M. fire broke out suddenly on all floors of the building and within a few minutes was beyond the control of the fire department. As it was now impossible to save this building, the firemen turned their attention to saving nearby buildings. A two-story brick building (containing dry goods) which was 35 feet west of the burning building, had taken fire. The fronts of the frame buildings on the west side of the burning building also caught on fire. At this point the west wall of the building fell in, and but for this fact the block to the west would also have been destroyed by the fire.

Chemical Plant.

H-18960. SMETHPORT, PA., OCTOBER 16, 1922. The plant manufactured acetone, acetone oil and ketone. All the walls were of 12-inch hollow tile. The still house had a corrugated iron and steel frame roof. The roof of the power house was of composition covered 1-inch boards on steel trusses. The floors were of concrete. The plant formed one group of buildings. There were no fire doors, shutters or wired glass windows.

A man in charge of the still house filled one of the stills too full of the raw liquor and when the liquid was heated it expanded and ran over the floor of the still house. This liquid vaporized and formed so much gas that the men were driven from the still house. The doors on the east and west sides of the still house were open and the door on the south side of the boiler house was open. This formed an ideal arrangement for the volatile gases to be blown, by a west breeze, from the still house to the boiler house, where they were ignited by the boiler. The flame travelled back to the still house causing an explosion of vapor.

As soon as the liquid had boiled over, two men tried to run a hose from the pump house and turn water on to the still, but before any water reached the still the men were buried beneath the wall of the still house which was blown out by the explosion. These men were rescued but one man who was in the boiler house and two who were between the two buildings were burned to death.

The fire spread rapidly, heating a large number of drums of finished acetone stored in the nearby yard. Almost all of the heads of these steel drums were blown out. The loss to buildings and contents was heavy.

Orphan Asylum.

H-19073. SHAWBRIDGE, QUEBEC, AUGUST 16, 1922. A fire occurring at midnight completely destroyed the Hebrew Orphans' Home and caused the death of twelve persons, ten of whom were under 14 years of age. The orphanage was a three-story frame structure without any fire escape or means of protection against fire. There was no fire fighting apparatus in the village. The fire, starting from unknown cause, rapidly consumed the building. Twenty-nine boys sleeping on a balcony on the first floor were easily rescued. The caretaker, his wife and two children, and eight children in an adjoining room on the second floor were trapped and burned to death.

Schools.

H-19075. WATERVILLE, ME., DECEMBER 4, 1922. Four students at Colby College lost their lives in a fire which destroyed an old brick dormitory. The building burned very rapidly and as the sleeping quarters of the men were on the third and fourth floors but little opportunity was given them to escape. A student coming in on a train at 3 A. M. first saw the fire and entered the building, giving the alarm on each floor and escaping from the fire escape. Many of the men reached a fire escape which led to safety. One of the men tried to go down the stairs but lost his life. The other three men that were burned to death apparently were not aroused in time to make escape possible. The exact cause of the fire was undetermined as the structure was completely destroyed.

H-19086. COVINGTON, GA., NOVEMBER 28, 1922. Two children were burned to death and thirty injured in a fire which destroyed the High Point school building at Covington, Ga. The children who lost their lives were, with forty others, trapped on the second floor of the building when their exit was cut off by the fire which started on the first floor, and many of those who escaped with their lives were seriously burned before jumping to safety. Those who were not burned received fractured legs and arms. Mrs. Oscar Grant, who had charge of the pupils on the upper floor, was so severely burned in directing the escape of the children, that fears were expressed for her life. When it was discovered that fire had cut off their only means of safe exit, Mrs. Grant gathered the children about the windows and directed them in jumping to safety until all but two were out of the building. She then jumped through the flames, being seriously burned. The two children who were burned to death went down in the flames as the floor collapsed. They were boys of six and eight years. A funeral party passing the school discovered smoke pouring from all windows. The procession to the cemetery was halted, the hearse being sent ahead. The men and women of the party rushed into the building and saved many children on the first floor, but were unable to ascend the stairs on account of the flames. The building was a two-story frame structure. County and school authorities say that the building had been condemned more than a year ago as a fire trap.

H-19074. ST. BONIFACE, MANITOBA, NOVEMBER 25, 1922. Ten lives were lost in a fire which destroyed St. Boniface College on November 25, 1922. The exact cause of the fire is unknown. The dormitory building was a large four-story structure with sleeping quarters for 156 students and

members of the staff on the fourth floor. The fire originated shortly after 2 A. M. The local fire department received an alarm at 2:25 A. M. and when they arrived the fire had made great headway. The ladder truck of the department had been wrecked a few days previously and they did not have a ladder sufficiently high to reach the upper floor until an aerial ladder truck arrived from Winnipeg at 3 A. M. Many were unable to reach fire escapes and had to jump from windows. Fortunately none of these were seriously injured. The college, which contained many documents and relics of historic worth, was destroyed.

Dwelling.

H-19069. WINTHROP, MASS., DECEMBER 25, 1922. Burns received when her clothing ignited from a blast of flame that occurred when she poured kerosene on a furnace fire caused the death of a woman. She had thought the fire was out. Another occupant of the house heard the explosion and smothered the flames with a coat, but not in time to save her life.

H-19071. WORCESTER, MASS., DECEMBER 25, 1922. A ten-year-old boy was burned to death in a fire that destroyed the family residence. The boy occupied a room on the second floor, almost directly over the Christmas tree that had been set up in a downstairs room. It is believed that a short circuit in the wiring of the electric lights with which the tree was decked, set the tree afire and the fire communicated to the surrounding woodwork. The blaze occurred about four o'clock in the morning. The parents and four other children escaped.

Warehouse.

H-18918. PHILADELPHIA, PA., OCTOBER 4, 1922. The building was a six-story structure of ordinary construction and with no interior protection. The fire was discovered by a watchman in an adjoining building. When the firemen arrived they found the fire on the second floor in a stock of dry goods. The fire had gained some headway and was extending through the building but was checked before destruction of contents or serious damage to the building.

Four firemen had carried a line of hose up on the elevator with intent to cut off the ascent of the fire. As the elevator neared the top of the shaft it was held fast and the men were caged in with no escape. The elevator was electrically operated and it was found that the electric device was affected by the heat and the car being equipped with safety catches did not drop to the ground floor. After the fire the bodies of the men were found lifeless.